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DIV. INSECTS.

E. A. Schwarz

FIFTEENTH REPORT
OF THE
STATE ENTOMOLOGIST
OF
MINNESOTA

TO THE GOVERNOR
FOR THE YEARS 1913 AND 1914

NINTH REPORT OF F. L. WASHBURN

Insect Conditions in 1913 and 1914

Useful Birds found in Minnesota

Nursery Inspection 1913 and 1914

Tree Insects

Spraying

Index to Insect Life

Fly Control

Warble Flies

Truck Crop Insects

Wire Worms

Preliminary Notes on Odonata

Acridiidae of Minnesota

AGRICULTURAL EXPERIMENT STATION
ST. ANTHONY PARK, MINN.
DECEMBER 1, 1914

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AGRICULTURAL EXPERIMENT STATION
ST. ANTHONY PARK, MINN.
DECEMBER 1, 1914



Citizens are urged to plant the Japanese Hydrangea, which blooms all summer, or the taller, more erect Japanese Snowball, both comparatively free from insect attack, in place of the badly infested common Snowball.

PRESS OF
HARRISON & SMITH CO.
MINNEAPOLIS

LETTER OF TRANSMITTAL

STATE EXPERIMENT STATION,
ST. ANTHONY PARK, MINN.,

To His Excellency, A. O. Eberhart, St. Paul, Minn.

DECEMBER 1, 1914.

DEAR SIR:—Complying with the law, I take pleasure in submitting herewith the Fifteenth Report of the work of the State Entomologist, from December 1, 1912, to December 1, 1914, covering insect conditions in this state during that period. The financial statement, however, necessarily covers the fiscal years, August 1, 1912, to August 1, 1914.

The season of 1913 was a normal year as far as insect pests were concerned. There was no marked injury from grasshoppers and but few complaints reached us of this pest. This was probably due to a vigorous growth of grain and weeds as well as to favorable weather conditions. Given, however, a few dry seasons in succession, and we will doubtless suffer from these insects as we did in 1910 and 1911. In fact, this pest may have been abundant in 1913, but on account of vigorous crop growth and abundant weeds, their work was not noticed. Fortunately, this Department has found a practical, effective and cheap way of combating grasshoppers in this altitude. Conditions in 1914 were practically the same as those in 1913, and no outbreak of grasshoppers was reported.

The same comments apply to the Chinch Bug, only two reports having reached us in 1913. As in the case of the preceding insect, we will at times, when conditions favor, be afflicted to a greater or less extent with this enemy of grain and it will doubtless continue to be of periodical occurrence.

An interesting observation was made by the Entomologist in June, 1914, in connection with the Chinch Bug; namely, the finding of these insects in a grain field in Clearwater County, far north of what has been regarded as their normal range in Minnesota. Twelve years ago we found a record in Lugger's notes of the occur-

rence of the Chinch Bug near Lake Vermillion, but were unable to verify it. The general belief had been that this insect was confined to the southern and central parts of this state, and this record from Clearwater County is of interest both to the Entomologist and to the farmer.

A number of reports have been received, as in years past, upon the work of the Wheat Stem Maggot, which is evidently of wide distribution, although it has not, so far, been responsible for any serious, wide-spread injury. From its causing the so-called "bald-heads" in wheat, it is always a source of alarm amongst the farmers.

There have been the usual number of inquiries regarding flies affecting stock, particularly those troubling horses.

Under the head of household insects, we may mention inquiries for remedies for bed bugs, carpet beetles, and clothes moth, and instructions have been forwarded to correspondents in each case. To this list we may add insects which infest flour, meal and other cereals, as well as flour mills themselves. Housekeepers in the Twin Cities complain frequently of "weevils," or "worms" or "bugs" in their flour. We feel that primarily in this case the fault lies with the millers,—that is, the mills are the original source of infestation and that it behooves the millers to take special precautions to keep these insects out of their flour and thus avoid boycotts upon their brands by distressed housekeepers. To a certain extent, however, the latter are responsible for allowing these insects to get a foothold in the household, and in *Insect Life*, Vol. 1, No. 11, the Entomologist has written his views upon this condition.

The passing of our shade trees, particularly the oak, due to both insect work and fungus disease, is alarming. The Entomologist has done everything possible within his province in the way of publications, press articles, personal solicitations, lectures, etc., to create public sentiment in favor of conservation of our trees. Dead and dying oak trees left standing are a menace to sound trees and should be destroyed. See, in this connection, contribution to this Report upon "Some Important Tree Insects," by Mr. A. G. Ruggles, p. 54.

The Cottony Maple Scales has been very destructive in some localities and there have been the usual number of inquiries regarding Buffalo Tree-hoppers, Larch Saw Fly, Cecropia Moth, Spiny Elm Caterpillars, Elm Borers, Oak-leaf insects, Slugs on plums,

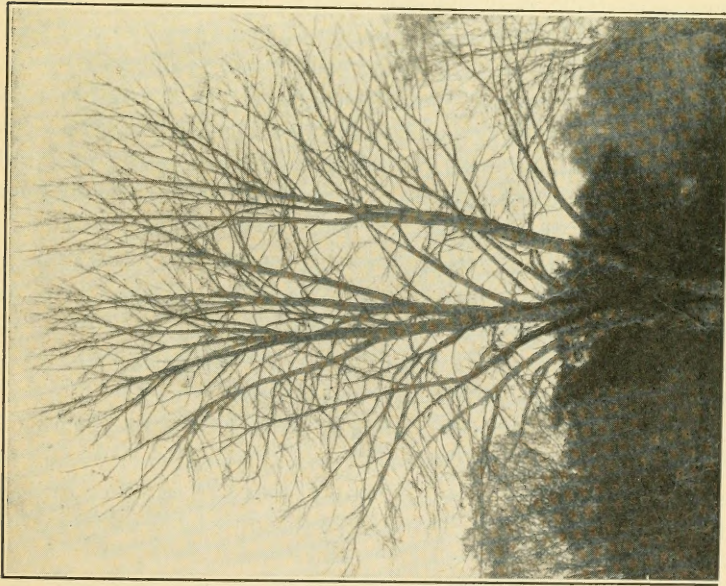


FIG. 1. Basswood tree defoliated by fall canker worm,
Lake Minnetonka, June 19th, 1914.

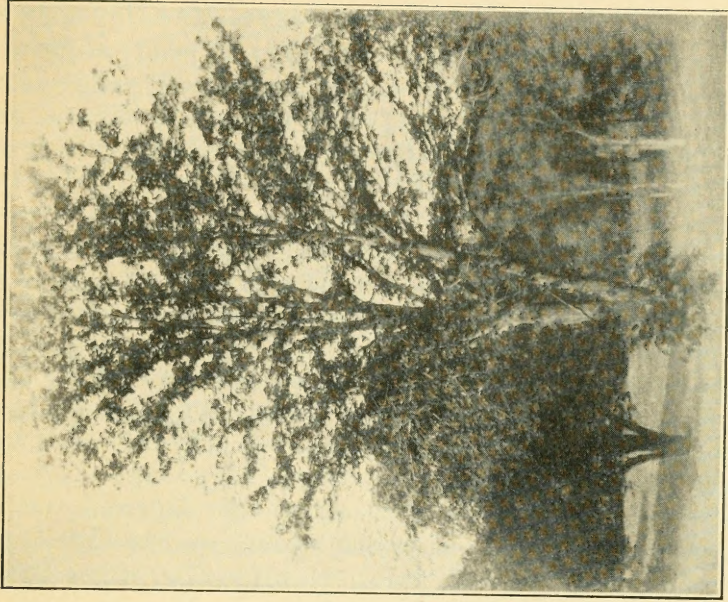


FIG. 2. Same tree as in Fig. 1, with new leaves,
July 3rd, 1914.

Apple Aphis, Apple Leaf-hopper, Lilac Borers, Bronze Birch Borer, Plum Curculio, Elm Aphis, Pine tree insects, Oak Gall insects, etc.

Basswoods in certain localities, notably at points about Lake Minnetonka, were badly infested in the spring and early summer of 1913 with Geometrid larvae or Measuring Worms,—in some cases the trees being almost defoliated. Subsequent developments proved this caterpillar to be the Fall Canker Worm, *Alsophila pom-etaria*.

On November 1st, 1913, the Entomologist was at Lake Minnetonka and observed thousands of the wingless female moths of this species ascending the trees which had suffered during the summer and under which the mature canker worms had entered the soil during June or July to pass the pupal or resting stage. On the above date, males were observed fluttering about the females and in the air, possibly in the proportion of about one male to every twenty females. Mating was in progress at the time. Many eggs had already been deposited. The lateness of the appearance of this insect was all the more remarkable because we had had freezing weather for several days previous to November 1st. Upon November 4th, the same conditions prevailed as on November 1st, and one property owner at the Lake, appreciating the warnings of the Entomologist, took vigorous measures to combat these pests upon the basswoods. Upon November 15th we found males and females alive in the midst of a light snow storm and temperature not far above freezing. Since that date, November 15 to December 1, 1913, remarkably mild weather prevailed and we predicted a serious attack upon the basswoods, locally, in the spring of 1914, unless prompt measures were taken in the spring or proper applications made to the eggs that winter.

As anticipated, the spring of 1914 found us suffering from attacks of this same pest, increased a hundredfold over the numbers of the preceding year. Elms were attacked as well as basswoods, and fruit trees to a limited extent. Many appeals for help were sent this office, which were responded to as far as possible, though the Entomologist felt obliged to remind these parties that if the warning and directions for prevention published in the State Press several times by this Department in the summer and early fall, had been followed, their trees would have been preserved from injury.

Trees defoliated in the spring of 1914, for the most part leaved out in midsummer, though the foliage was not as heavy as it would

have been normally at that period. Defoliation of this sort for a number of successive years would probably result in the death of the trees.

The Entomologist again during the past summer and in the early fall of this year urged property owners, whose trees had suffered this season, to prevent repetition of this misfortune by applying Tree Tanglefoot to their trees in September or early October, and many followed this advice. In fact, in the town of Minnetonka Beach, hundreds of trees were treated, and those property owners who took this precaution, now (November 15) have the satisfaction of seeing hundreds of dead female moths, and large numbers of males, ensnared in the sticky bands about their trees. This year females were first observed climbing the trees (basswoods, primarily, and also elms and even maples and oaks) on October 15. No males were seen at that time, though they appeared in small numbers a few days later, about a week after the appearance of the females. On October 22 these females were very abundant and the number of males increasing, the latter being exceedingly numerous on October 26th to the 30th. Mating was in progress on October 24. Eggs have been laid in large numbers on treated trees just below the sticky bands. It would be well to destroy these eggs with a strong caustic solution before next May, and we would suggest renewal of bands about trees in affected areas, at that time, if the old bands are not then sticky. Thousands of eggs, of course, are already upon infested trees which were not treated with Tanglefoot, but they are so scattered over the trees that any treatment offered would be of but little avail. The renewal of the bands next spring, or the use of new bands upon trees now untreated, is advised for the purpose of checking the spreading of the caterpillars crawling from tree to tree. Occasionally a few of these moths "hold over" until Spring before issuing from the ground. As our illustrations show, banding is very effective, but where the band has been allowed to be covered with leaves, or twigs, or dust, a bridge has been formed over which the pests have crossed. Hence the tree owner should keep the barriers free and sticky, by picking off the leaves and "combing" bands with a coarse brush when necessary. Some tree owners also have been careless in applying the mixture, neglecting to smooth off the rough bark, with the result not only of wasting the Tanglefoot, but also leaving unguarded cracks and crevices through which a portion of the moths at least could get above the band.



FIG. 3. Wingless female moths of fall canker worm, gathered on bark of basswood beneath the tangletfoot band.
Lake Minnetonka, Oct. 31st, 1914.

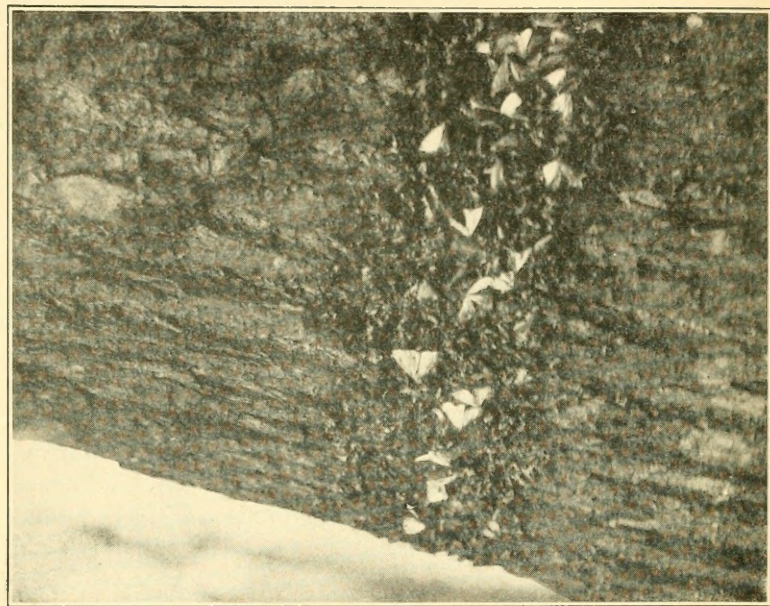


FIG. 4. Male and female moths of fall canker worm caught in tangletfoot band. Lake Minnetonka, Nov. 2nd, 1914.

We doubt if a low temperature in the early fall renders Tangle-foot useless, for on October 26, when it was 30 degrees Fah., we found bands on our own trees still sticky, even on the north side of the trunks. On Nov. 16 with the thermometer at 15° the bands were sufficiently sticky to prevent any insect crossing.

The outlook in regions affected this year, and where proper precautions as above outlined were not observed, is indeed serious, unless some now unforeseen relief, such as extensive parasitism of eggs, or their destruction by predaceous mites or birds, or by bacterial or fungus disease in the caterpillars next spring, come to the rescue. This pest may last for from three to five years.

Property owners whose trees were at all injured in the spring of 1914, and many whose trees were not touched, will probably, if they have not taken proper precautions, see their basswoods, and possibly other trees, stripped of their leaves in the early summer of 1915. As explained above, this might have been largely or entirely prevented.

The White Grub, the larva of *Lachnosterna* *sp.* is a pest of growing importance in Minnesota. It has always been complained of periodically in connection with lawns and occasionally strawberries, but, in recent years, it has increased to such an extent that it has called for extensive work, both to determine the different species causing the injury and also to devise practical remedial measures. Serious complaint regarding this insect comes to us in connection with corn, strawberries, evergreen seedlings, and as noted above, lawns, golf links and pasture lands. Similar injuries and even more severe are reported from Wisconsin. See, in this connection article by Mr. Moore on "Truck Crop Insects," p. 64.

Nursery and Orchard Inspection. This work has been increased a hundredfold since the new Inspection Law went into effect. See p. 20.

Special Work. So closely connected is the work of the State Entomologist (as outlined by the law) with that of the Experiment Station, that no report of this Department is complete without reference to the Station work in the line of economic entomology. Hence we include here brief articles from other entomologists in the Entomological Division of the Experiment Station, of which the writer is chief.

Mr. Ruggles writes upon "Spraying in Minnesota" and "Some Important Tree Insects," p. 52; Mr. Howard upon "Some New Suggestions in Fly Control" and "Warble Flies," pp. 57, 61; Mr.

Moore has an article upon "Truck Crop Insects" on p. 64; and Mr. Williamson one on "Wire Worms" on p. 69.

The work indicated by most of these articles has been done entirely, or in part, with the funds appropriated for the State Entomologist.

A Corn Bill Bug, *Sphenophorus venatus*, has done considerable damage to corn in this state and is the subject of original research work on the part of Mr. O. G. Babcock, formerly in our employ, but now in the West. This beetle was first reported by Mr. Babcock in 1912 to be *S. parvulus*, and Mr. Babcock is also responsible for the summary in connection with this insect on page 73 of the Fourteenth Report of the Entomologist. This identification has since been corrected, and the correct name is given in the first part of this paragraph. He also reported another species, *S. vaea*, as injuring corn. He states that the first named species did not appear in 1913 until May 27th. Work with this pest has been carried on in breeding experiments at the Station and by observations in the field.

Fly Campaign. In an effort to make our citizens aware of the dangers connected with the tolerance of the common House Fly, the Entomologist has given many lectures upon this subject in different parts of the state; has published several circulars; also in co-operation with the State Board of Health, has issued several thousand large, illustrated posters, and made a special feature of a striking exhibit at the State Fair in September, 1913. This exhibit is described on page xii.

There seems to be a rapidly growing sentiment in Minnesota against this disease-carrying insect, due, in part, we believe, to the efforts of this Department and the State Board of Health, as well as to a general recognition everywhere of the importance of this subject. In consequence of this sentiment, possibly, the House Fly does not appear to have been as abundant during the summers of 1913-1914 as formerly, although of course we found it in large numbers in certain localities especially favorable to its increase. It is to be noted that the doctrine of municipal and individual cleanliness is more potent in this connection than merely the trapping of the fly. Mr. C. W. Howard of this division has been making the House Fly the subject of thorough investigation and will report upon his work later. The effect of the presence of automobiles in large numbers, supplanting the horse, undoubtedly plays a part in this lessening of the fly evil in cities.

Legislation Affecting the State Entomologist. In the early part of 1913 the legislature passed a new Nursery and Orchard Inspection Law in Minnesota (see p. 28), making inspection compulsory and establishing a flat fee of \$5.00 for issuing of certificate (which money goes into the general revenue of the state).

See p. 39 for discussion of the plan to separate the office of the State Entomologist from the University.

Shade Tree Insects; Orchard Spraying. See pp. 52 and 54.

Publications:

1913.

February.	Circular No. 26.	"The Minnesota Fly-Trap and Suggestions for a Campaign Against the House Fly."				
May.	Circular No. 27.	"Twenty Common Insects of the Vegetable Garden and Remedies."				
April	Vol. II, No. 2	Minnesota Insect Life				
May	"	"	3	"	"	"
June	"	"	4	"	"	"
July	"	"	5	"	"	"
August	"	"	6	"	"	"

These numbers of "Insect Life" contain articles on "Orchard Spraying," "House Fly," "Field Mice," "Worms on Basswood," "Rabbits and Ferrets," "Grasshoppers," "Flies on Stock," "Fall Methods of Controlling Insects," "Cottony Maple Scale," "Wheat Stem Maggott," etc.

In addition to the above, press articles were sent from time to time to our county and city papers for publication.

1914.

April	Vol II, No. 7	Minnesota Insect Life				
May	"	"	8	"	"	"
June	"	"	9	"	"	"
July	"	"	10	"	"	"
August	"	"	11-12	"	"	"

We note in this year's issues, articles on "Spraying," "Clover Seed Midge," "Cabbage and Onion Maggot," "Cut Worms," "Rats on the Farm," "English Sparrows," "Buffalo Tree-hoppers," "Cucumber Beetles," etc. Upon p. 73 will be found a complete index of Volumes I and II of this publication.

The following circulars have been published by the State Entomologist's Department in 1914:

Circular No. 28, Jan. 20, 1914, Fumigation of Greenhouses with Cyanide, pp. 5, illustrated, by Wm. Moore.

- Circular No. 29, Jan. 29, 1914, Two Raspberry Pests Which May Be Controlled by Spring Pruning, pp. 4, illustrated, by Wm. Moore.
- Circular No. 30, June, 1914, Some Tree Destroying Insects, pp. 8, illustrated, by A. G. Ruggles.
- Circular No. 31, Nov. 15, 1914, Report upon State Nursery and Orchard Inspection, 1913-1914, pp. 31, one colored plate, by F. L. Washburn.
- Circular No. 32, Nov. 25, 1914, Useful Birds Found in Minnesota, pp. 19, three colored plates, by F. L. Washburn.
- Circular No. 33, Nov. 30, 1914, Control of Flies in Rural Districts, pp. 12, by C. W. Howard.
- Bulletin, No. 141, (Technical) July, 1914, Acridiidae of Minnesota, pp. 91 and Index, by M. P. Somes, Station Publication.

Insectary and Experimental Garden. Mr. William Moore, Assistant Professor of Entomology, was added to our staff in October, 1913, and has charge of insectary methods and experiments. He appears to be placing this feature of our work upon an excellent footing. We have been granted by the Director of the Station a plot of ground consisting of about $2\frac{1}{2}$ acres and including some orchard land for experimentation. Some of this was sown in clover for work with clover insects, and a part plowed and utilized by planting thereon a few truck crops for experimental work.

Mr. Moore reports 127 general experiments carried on during the year, and 75 others of a special nature in charge of the heads of different sections.

Insect Collections. Considerable additions have been made to our collections in Hymenoptera, popularly referred to as the group containing the Bees, Ants, and Wasps. This has been done, primarily, for the proposed work upon this order of Minnesota insects, a project approved by the Director of this Station.

Exhibits. Reference has already been made to the House Fly Exhibit at the State Fair in 1913. In this exhibit a large and very accurate model of the House Fly was shown (see plate), 4 feet long, with filth attached to feet, wings and hairs of the body. There was also a model of a farm house and outbuildings, with flies going from the latter, and from a manure pile, into the windows of dining room and sick chamber. Over the fly exhibit was suspended a red electric light globe which flashed every 40 seconds, that being the rapidity at which (according to a recent census report) a child died somewhere in the United States under five years of



State Entomologist's Exhibit at Minnesota State Fair, Sept. 1913; large model of house fly and models of fly-infested farm buildings

age. A label attached explained this and stated that a goodly proportion of these deaths were due to fly-borne diseases.

In addition to this feature in our booth in 1913, house flies were shown alive, in maggot and pupal stages, as were also mosquitoes, and the tables were filled with cases showing mounted insects of economic importance. This booth in the Agricultural Building was crowded with visitors practically all the time.

In the Horticultural Building there was an exhibit of different spray pumps, nozzles, insecticides, and one power sprayer in action in charge of Mr. Ruggles and Mr. Peake. Appropriate signs in different parts of the Fair Grounds directed visitors to these two booths. The spraying exhibit was repeated in 1914.

Correspondence and Lectures. In the vicinity of 2,000 letters were written by the Department in 1913, as well as the usual number of postal card replies, largely in answer to inquiries regarding insects. In 1914 the number was somewhat greater.

Your Entomologist delivered, during 1913, twenty-six lectures in different parts of the state. A large proportion of this number was devoted to the subject of the House Fly and presented before women's clubs, schools and civic bodies. These lectures dealt with the habits of this insect and its control in cities and towns, and were illustrated by lantern slides. A few lectures were given on "Mimicry in Insects," one before the State University, and at other times at St. Paul schools. "Grasshopper Control" was the subject of another lecture. Papers were also read in Cleveland, Ohio, before the American Association of Economic Entomologists and the American Association of Horticultural Inspectors. At the same place, a report was made of the work of Entomologist's Employment Bureau, carried on by the American Association, of which Bureau the writer was director during 1912-1913. This Bureau is managed by the American Association and is planned to secure positions for entomologists and to provide institutions seeking entomologists with desirable men, at the mere cost of operating.

In December, 1913, the Entomologist spoke at Atlanta, Ga., before the two National Associations above mentioned. Occasional lectures were given during the winter, and in June, 1914, we participated in "University Week," lecturing in six Minnesota towns.

Articles and Illustrations in This Report. Special attention is called to articles in this report, written by men whose work has been entirely or in part supported by funds in the State Entomolo-

gist's Department, distinct from University funds, and attention has been elsewhere called to the fact that the Station work and State Entomologist's work are so closely allied that a report upon the one must necessarily to a certain extent include a report upon the other.

The excellent contribution from Professor A. D. Whedon of Mankato State Normal, however, upon Odonata or Dragon Flies of Minnesota, is upon a different basis. It has been the plan of this Department, a plan inaugurated by the late Professor Lugger, to present to the citizens of Minnesota a popular treatise upon each of the leading orders of insects found in the State, emphasizing the economic forms. Note in this connection the comprehensive reports of Professor Lugger upon "The Beetles of Minnesota," "Butterflies of Minnesota," "The Hemiptera of Minnesota," Grasshoppers and Crickets," and later the very brief report by the writer upon the "Diptera or Two-winged Flies of Minnesota." Some groups, while of interest to the amateur, do not, on account of their comparatively small size, call for such extended reports as the above. Hence we feel very fortunate to obtain, in line with the above plan, this contribution upon the Dragon Flies of Minnesota, for this report. We also include here Professor M. P. Somes' excellent report upon "The Acridiidae of Minnesota," published as Bulletin No. 141 (Technical) of the Minnesota Experiment Station, July, 1914. This work was done entirely under the direction of the State Entomologist and with the funds in his state department. Because of this, and since we believe it one of the best publications in that particular field, representing in part the careful work of three years in Minnesota, and feel that it will be useful to specialists in this group and to the schools in this state and elsewhere, we include it in the 1913-1914 report. The three colored plates were first used in the Fifteenth Report, 1912-1913, but since their presence is necessary for the more perfect understanding of Mr. Somes' paper, in which occur many references to the plates, we hope we may be pardoned for repeating them here. These plates represent excellent work, both by artist and lithographer, as do also the three colored plates of heads of birds, finished by the quadri-colored process. The colored plate illustrating San Jose Scale and Crown Gall is made by the same process. The paging in Mr. Somes' article, since it was first printed as a technical bulletin from the Experiment Station, does not conform to the paging in the body of this Report.

Acknowledgments. We take pleasure in acknowledging the generous co-operation during the two years just past of the entomological force, the Director of the Station, and members of the Station staff in general.

We wish particularly to acknowledge the co-operation of Mr. H. L. Viereck, specialist in Hymenoptera, who has been of material service to us in the work on the Hymenoptera of this state.

The press, as usual, has been courteous and helpful. Nurserymen and florists have willingly complied with the provisions of the Inspection Law and we feel that the years of 1913 and 1914 have been successful in this particular.

We are deeply indebted to Professor Whedon for complying to our request for a contribution on Minnesota Odonata.

The Governor of the State, to whom this report is addressed, has shown his interest and co-operative spirit in various ways.

Respectfully submitted,

F. L. WASHBURN.

State Entomologist.

Financial reports for 1913 and 1914 are herewith appended.

FINANCIAL STATEMENT,* FISCAL YEAR, AUGUST 1, 1912. TO AUGUST 1, 1913.

Apiary	\$ 25.00	
Books, periodicals, and index cards.....	98.58	
Clerk, accountant, and stenographer.....	825.00	
Cuts and etchings for Report.....	63.76	
Drawings and colored plates for Report.....	369.16	
Field notes	20.27	
Insecticides, apparatus, and reagents.....	58.28	
Office supplies, stationery, etc.....	77.90	
Photographic supplies	20.40	
Printing circulars, Insect Life, cards, etc.....	190.25	
Salaries and traveling expenses of Entomologist's staff.	1,862.11	
Salaries and traveling expenses of Field assistants.....	1,257.70	
Substitute stenographer	106.25	
Supplies for laboratory and insectary.....	50.47	
Telephone and telegraph service, freight and express charges, and postage.....	319.77	
	<hr/>	
	\$5,344.90	
Fund		\$5,000.00
Credit by Nursery Inspection, etc.....		464.99
		<hr/>
		\$5,464.99
		5,344.90
		<hr/>
Balance on hand.....		\$ 120.09

*Bills covering details of above on file in State Auditor's office.

FINANCIAL STATEMENT,* FISCAL YEAR AUGUST, 1913, TO
AUGUST 1, 1914.

Appropriations	\$6,300.00	
Railroad rebates for excess fares	162.91	\$6,462.91

Expenses.

Apparatus	\$ 77.54	
Assistance and working expenses	545.88	
Clerk, accountant and stenographer	808.31	
Etchings, drawings, and colored plates for Report	321.30	
Entomological periodicals	16.42	
Expenses of assistants	223.09	
Freight and express	67.94	
Insecticides	53.32	
Laboratory supplies	106.87	
Lantern slides, etc., for Farmers' lectures	18.18	
Models of insects for fair and lectures	116.85	
Nursery Inspection expenses for June	242.15	
Office Supplies	245.15	
Photographic supplies	4.28	
Postage (including report)	102.00	
Printing of circulars, cards, report, etc	605.00	
Salaries of Assistant Entomologist and other assistants	2,578.85	
Telephones: long distance and telegraph messages	53.70	
Traveling expenses of Entomologist	197.24	6,384.42

Balance \$ 78.49

*Bills covering details of above on file in State Auditor's office.

Statement of sums appropriated by the legislature, the aggregate amounts drawn from the State Treasury and balance unexpended, are correct as shown by the records of this department.

Samuel G. Iverson

State Auditor.



I. L. WOOD, DEL.

J. L. ENGRAVING, Mpls.

SOME USEFUL MINNESOTA BIRDS

Plate 1.

USEFUL BIRDS FOUND IN MINNESOTA *

F. L. WASHBURN.

There have been so many and so insistent demands, particularly from the schools of the state, for information about Minnesota birds, and requests for Bird Charts similar to the Insect Charts distributed by the Entomologist to the schools several years ago, that we hope to obtain from the legislature at the coming session \$3,000 to prepare and distribute with educational text about 9,000 such charts illustrating our useful birds. Rather than depend, however, upon a resource available only in the future and of an uncertain nature, we have endeavored to discuss and figure a few of our representative insect-eating birds in this Report, trusting that such contributions will be helpful.

Disregarding any sentimental views upon birds caused by their song and beauty, and basing our opinions as to their usefulness or the contrary purely upon a study of their food-habits at different seasons, and in different years, it is believed that we may safely say that almost all of our common birds, including a goodly number of hawks and owls, the so-called "birds of prey," are useful to the agriculturist and fruit-raiser. Some are more so than others, a few are of doubtful utility, and a still smaller number, representing a very small proportion of our bird fauna, we now regard as injurious in the light of our present knowledge. It is possible that additional investigation may cause us to entertain a different opinion of the latter. A farmer, or orchardist, or berry-raiser, or truck gardener, has a perfect right to protect his crops from excessive bird injury and we have seen occasions where resort to a shotgun was justifiable, but, in such cases, one should be absolutely sure that the bird he seeks to destroy is really guilty, that the injury caused is serious, and, particularly, that the benefits accruing from the destruction of a large number of insects on the part of the bird in question, during the nesting season, do not more than compensate for the few berries or small amount of other fruit or of garden or farm crop destroyed. For this information, the agriculturist has to rely mainly upon the results of the studies of experts in this line, since it requires long and careful observations and the exam-

* Also printed as Circular No. 32.

ination of a large series of birds' stomachs to place this matter upon even an approximately accurate basis.

In this connection, we should note that the parent birds secure the enormous number of insects, which form the main part of the food of the nestlings, as near the nest as possible; the nearer, the more trips each day and, consequently, the more insects consumed. A bird nesting a mile away from a berry patch is not going to cover that distance seeking for insects if it can get them near at hand. Therefore, it behooves the agriculturist to encourage nesting of birds upon his own place.

As evidence of the voracity with which birds attack insects, the writer might cite his observations at Lake Minnetonka in September of the present year at a time when enormous numbers of "gnats" (Chironomids) filled the air, producing, at sunset and after, a humming noise audible for a long distance. These flies are of no special importance to the agriculturist, but by their immense numbers are sometimes disagreeable accompaniments of a sojourn near bodies of water, their larval life being aquatic. In this particular instance, these huge swarms attracted hordes of Tree Swallows massing for their southward migration. These beautiful birds, thousands of them, remained in the vicinity of the lake for several days, and must have made a decided impression upon the numbers of the flies. They not only caught these gnats in the air, but clustered upon trees and even lit upon lawns, seeking the flies in places where the latter had sought shelter from the wind. In an effort to determine how great had been the destruction of gnats by the swallows, the writer secured three of the birds and examined their stomachs. These were found distended with immense quantities of flies, but in such disintegrated condition that anything like an accurate count was impossible. By turning the lens of a camera toward the sky, the accompanying photographs of the swallows were obtained. With hundreds of them on the wing, there were, of course, many out of focus. The indifferent pictures, however, may illustrate the fact that the air was literally full of swallows.

Reference has been made to the raptorial birds, our hawks and owls. From time immemorial practically, the farmer's boy has felt justified in shooting every hawk and every owl met with, under the impression that he was doing agriculture a good turn thereby. Whenever he could bring down a crow or shoot into a bunch of blackbirds, he felt an honest conviction that his action would be approved at home; hence he returns triumphant, proudly display-

ing his dead crow, or hawk, or owl as he walks the village street, while perchance the "partridge" or "quail" or chicken shot out of season is snugly tucked away in the pocket of his hunting coat.

As a matter of fact, most of our hawks and owls are decidedly useful; crows frequently pick up white grubs turned up by the plow, and the writer has seen in Minnesota both blackbirds and crows in the stubble eating large numbers of grasshoppers, in a



FIG. 5. Tree swallows in enormous numbers catching gnats.
Lake Minnetonka, September, 1914.

bad grasshopper year. Of course both of these can be and are at times injurious in corn fields and in grain. And the poultry raiser, particularly if living near timber, will occasionally lose poultry on account of the presence of hawks, but practically never on account of the two or three birds of prey whose heads are shown in the accompanying plates. There are one or two notoriously bad hawks, but the little sparrow hawk, Fig 13, is a great eater of grasshoppers, and the marsh hawk, Fig. 11, so plentiful about meadows and on the prairie, is a constant hunter of field mice and other

animals; while the screech owl, Fig. 4, is a useful resident upon any farm as a mouse killer.

Teachers in our public and district schools have an excellent opportunity to inculcate in the minds of their boys a desire to study the habits of birds and to discourage the maiming and killing of song birds or the destruction of their nests and eggs. Usually the small boy who would "make a collection" of birds' eggs wishes to do so because they attract him partly by their color, partly perhaps by the difficulties involved in securing them, and no doubt also influenced by a desire "to collect" which sometimes makes imperative demands upon both young and old. The loss to agriculture by such collections is decidedly great, a loss which is avoidable if the boy's ambitions can be turned into other channels. Acts of this kind, egg-collecting without a license, and the killing of song birds are, for the most part, punishable by law, but if the child can be led into observance of these laws through an intelligent interest in the birds themselves, the result is better than if fear is the instigating cause. Enough has been said perhaps to emphasize the need upon the part of both adults and young of a careful and discriminating judgment of birds based upon their food habits before condemning them, and the need of encouraging in every way possible their continued presence on farm, in garden, and in orchards by boxes for wrens, bluebirds, and martins, and by exposing material used in nest building; by winter feeding and by fostering generally a wise and humane policy towards our feathered associates. The recent enactment of laws by Congress protecting birds during their migration is one of the best evidences of the growth of a higher, and at the same time, a more practical sentiment in this direction. A brief description of the birds figured on the plates follows:

Except where noted, the male bird is figured and described.

ROBIN.

(Plate I, Fig. 1.)

What would a country home be without robins on the lawn! As a rule, the robin, which is really a thrush, is useful, although a large per cent of its food is fruit. Because of our general attachment to the bird, agriculturists will probably try every possible protective means before having recourse to the shotgun when fruit is to be saved. Individuals of this species are found frequently very late in the fall, and occasionally where evergreen thickets afford

shelter, even in the winter. The writer found them in 1885 on November 9th in Otter Tail County. They have been observed in Minnesota, evidently returned from the south, as early as February, but generally they begin to arrive the latter part of March or early in April, welcome harbingers of spring.

.YELLOW-RUMPED WARBLER; MYRTLE WARBLER.

(Plate I, Fig. 2.)

One of our more common warblers, breeding in the northern part of the State and in Canada and observed in vicinity of Minneapolis about April 15th. Found in small flocks amongst bushes and other low growth. Its food consists almost entirely of injurious insects, a small per cent only represented by fruit and seeds. It is particularly fond of scale insects and plant lice, and is something of a fly-catcher as well. It is a little over five inches in length, and can be easily recognized by the presence, in the adult males, of a bright yellow patch on rump, on top of head, and on each side of breast. General colors,—grayish with darker stripes, throat white, more or less black on breast and lower parts. In the young and in the adults in late fall, the colors are duller and the characteristic yellow of the crown and rump either very dim or absent. Length, about five and a half inches. Nests in evergreens a few feet above the ground; eggs, whitish-gray blotched with brown or blue.

CHICKADEE.

(Plate I, Fig. 3.)

Found as a resident throughout northern part of the United States and in Canada and Alaska. Dear to us because of its cheerful activity in the cold of winter when almost all other bird friends have left us. From an economic standpoint, a great benefactor, for not only does it consume large numbers of insects in summer, but more than one-half the winter food consists of insects and their eggs. The eggs of plant lice make up one-fifth of the entire food; in fact, the destruction of these eggs on fruit and shade trees is the chief beneficial work of this bird in the winter, and the good it does in this way must not be underestimated. Examinations of the stomachs or crops of these birds have shown that sometimes more than four hundred and fifty eggs of plant lice are consumed by one bird in one day. Eggs of canker worms and tent caterpillars are also eaten. Four stomachs or crops examined showed, as the result of a single day's feed, one thousand and

twenty-eight eggs of canker worms. Four others contained about six hundred eggs of canker worms and a hundred and five mature, female canker worms. Surely, if any bird deserves protection, it is this one. Such a familiar bird hardly calls for a description. Head, back of neck and throat, black; sides of head and neck, whitish; breast, white; sides, washed with brownish yellow. Length, about five and one-half inches. Nests in old stumps and decayed trees, preferably birch; holes generally not far from ground. In addition to its cheerful "chick-a-dee-dee" it has a number of other notes, some of them extremely musical.

SCREECH OWL.

(Plate I, Fig. 4.)

Varies greatly in color from reddish or rufous to gray. In rufous specimens, rufous above, generally showing fine black lines. Below, whitish, with feathers barred with reddish or rufous. Or, in grayish specimens, above, brownish gray with faint black markings mingling with brown. Length, about ten inches. This is a quite familiar bird about our orchards and barnyards, and as its food habits show, its presence should be encouraged. Of two hundred and fifty-five stomachs examined under the direction of the United States Department of Agriculture, one contained poultry; thirty-eight contained other birds; ninety-one contained mice; eleven contained other mammals; one hundred contained insects; two contained lizards; four contained batrachians; one contained fish; five contained spiders; nine contained crawfish; seven contained miscellaneous matter; two contained scorpions; two contained earthworms; and forty-three were empty.

WHITE-BREASTED NUTHATCH.

(Plate I, Fig. 5.)

The only one of our birds which is commonly seen "climbing" down a tree as well as up. About six inches long, gray, with white under part; top of head, black; back, bluish. Ranges practically over the entire United States and Mexico. Over one-half of its food consists of insects. Nests in holes in trees. This is one of the few birds which remain with us over winter, at which time we frequently find it associating with chickadees, downy woodpeckers, kinglets, and brown creepers. Its rather coarse note frequently repeated has been likened to the word "yank" repeated, with a nasal sound. A close cousin of this bird, the red-breasted nuthatch,



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has a somewhat more northerly range. The writer has collected both old and young of the red-breasted nuthatch at St. Vincent in August, and it perhaps finds there its southern limit in this State.

CHIPPING SPARROW: "CHIPPIE."

(Plate I, Fig. 6.)

One of our most common garden birds; unobtrusive, useful and welcome; easily recognized by its modest grayish and brownish colors and the chestnut or bay patch on top of head. Furthermore, it is very friendly; its somewhat monotonous "chipping" note is a common sound in many gardens and dooryards in this country. Eats seed in the fall, at which time its colors change somewhat. During the summer, it helps destroy various insects, including caterpillars, beetles, plant lice, etc. The chipping sparrow is a little over five inches long. Nests in trees or vines near house or in garden or orchard; nest generally lined with horsehair; eggs, four or five, bluish, with blackish or brownish markings.

YELLOW-BILLED CUCKOO.

(Plate 2, Fig. 7.)

A shy bird with back and long tail a fashionable brown; under parts, white; lower half of bill, yellow, except at tip. Constructs a loose nest of twigs and lays therein three, four, or five pale-green eggs, unmarked. This bird is generally silent but at times gives utterance to a note repeated in such a way that it sounds like some one calling the cows. Because this is heard sometimes in lowering weather preceding rain, the bird is called by many "rain crow." Without doubt one of our most useful birds and one of the few which will eat hairy caterpillars, such as tent caterpillars and fall web worms. Henshaw (U. S. Dept. Agr., Farmers' Bulletin 513) reports that one stomach which was examined contained two hundred and fifty American tent caterpillars; another two hundred and seventeen fall web worms.

The Black Billed Cockoo is perhaps more common in Minnesota and more generally met with than the above species.

RED-EYED VIREO.

(Plate 2, Fig. 8.)

Who has not heard and enjoyed the song of this bird emanating from shade trees along a village street on a hot day in summer? It is heard at a time when other birds are silent, and if one sees

the songster amongst the leaves, he will be found to be actively searching for insects, even while giving voice to his song. The nest is pensile, in a fork, and characteristic in its structure, containing strips of vines, bark of trees, frequently pieces of paper. This nest may be thirty or forty feet above the ground. Eggs, three or four in number, white, the larger end sparingly spotted. The bird is about six and a quarter inches long. Top of head, gray; white line over the eye, which is red. The remainder of body olive colored, except under parts, which are white. We found this species to be the most abundant of its family in the Red River Valley some years ago.

DOWNY WOODPECKER.

(Plate 2, Fig. 9.)

A true benefactor in that its food consists almost entirely of injurious insects, and it is with us both winter and summer. It is the smallest of our woodpeckers, being only six and four-fifths inches long. Black above; a scarlet band on back of neck; white on middle of back; under part, white; central feathers of tail, black; the outer ones white with black markings; wings, black spotted with white. Length, $6\frac{1}{4}$ inches. The female lacks the scarlet patch on back of neck. It nests in holes in trees. Often seen in winter in company with nuthatches, chickadees, and brown creepers. What little vegetable food it eats consists of seeds of poison ivy, sumac, etc. Seventeen Wisconsin specimens had eaten forty insect larvae, twenty wood-boring grubs, three caterpillars, seven ants, four beetles, a chrysalid, one hundred and ten small bugs, a spider, with a few acorns, small seeds, and a little woody fibre, apparently taken by accident with the grubs. Three-fourths of the food of one hundred and forty specimens examined by the Department of Agriculture consisted of insects. Nearly one-fourth consisted of ants, chiefly those which were caring for plant lice, or burrowing in wood.

BROWN CREEPER.

(Plate 2, Fig. 10.)

This inconspicuous, active bird being with us throughout the entire year is to be ranked amongst our most useful assistants in keeping down injurious insects, for it eats many insects in hibernating stage in winter besides consuming large numbers of insect eggs which would otherwise hatch in the spring. It appears to be

always in motion in the daytime, "creeping" over trunks and branches on the lookout for food. General color, brown more or less streaked with lighter colors; white below; about five and one-half inches long; end of tail feathers stiff and pressed against bark of tree after the manner of woodpeckers. Bill slightly curved.

MARSH HAWK (Female).

(Plate 2, Fig. 11.)

Male and female quite different, both in size and color. Adult male nineteen inches long, grayish above, the tail being barred with blackish; feathers above at base of tail (upper tail coverts) conspicuously white; breast, gray, fading into white on belly, where brownish markings are found. The adult female is twenty-two inches long, dark brown above, marked on head and neck with reddish brown; upper tail coverts as in male, conspicuously white; tail darker brown, barred with reddish brown; breast buff, the color fading on belly. Nests on the ground in marshes. This is pre-eminently a bird of the meadows and prairies, and is often seen skimming over the top of the marsh grass hunting its food, at which time the white of the upper tail coverts is conspicuous. It eats field mice, squirrels, rabbits, grasshoppers, frogs, reptiles, and occasionally small birds or poultry, but not often. The writer regards it as a useful bird to the agriculturist. Out of one hundred and twenty-four stomachs examined by the United States Department of Agriculture, seven contained poultry or game birds; thirty-four contained other birds; fifty-seven contained mice; twenty-two contained other mammals; seven contained reptiles; two contained frogs; fourteen contained insects; the contents of one were undetermined, and eight were empty. Dr. B. H. Warren examined fourteen stomachs with the following results: Seven had only field mice in their stomachs; three, frogs; two, small birds (warblers); one, a few feathers, apparently of a sparrow, and fragments of insects; one, a large number of grasshoppers, with a small quantity of hair, evidently of a young rabbit. This bird is recorded as having been observed in southern Minnesota in January.

KINGBIRD.

(Plate 2, Fig. 12.)

This is the policeman of our garden and orchard, bravely attacking large hawks and crows which might be disposed to do mischief. It is a typical flycatcher and consumes an enormous number of

insects and deserves our protection at all times. What few honey bees he takes appear to be mostly drones; examination of six hundred and thirty-four stomachs showed only 61 bees in 22 stomachs. Of these 51 were useless drones. On the other hand, it devours robber flies which catch and destroy honey bees. (From Biol. Survey Bull. U. S. Dept. of Agr.) Length, eight and a half inches; upper parts, dark gray, almost black on head. Concealed flame-colored crest on head; under parts, whitish.

SPARROW HAWK.

(Plate 2, Fig. 13.)

Our smallest and most beautiful hawk. Common in fields and along roadsides in the late summer and fall, at which time it consumes large numbers of grasshoppers. It also eats other insects, caterpillars, spiders, and at least one-quarter of its food consists of field mice, shrews, and field-dwelling house mice. It occasionally preys upon young birds but this is not a common trait of this species. Quoting from a Biological Survey Bulletin: "Out of four hundred and ten stomachs examined, three hundred and fourteen were found to contain insects, one hundred and twenty-nine small mammals, and seventy, small birds." We unhesitatingly class these amongst our useful birds. It is found throughout the United States, breeding wherever it is a summer resident; is about ten inches long; back, brownish red or rufous with black bars. Black band at end of rufous tail, the extreme end of which is white. Head, bluish with brown shadings. Under parts and sides spotted with black. The above brief description applies to the male bird. A hole in a tree is utilized as a nest; eggs, whitish or creamy, three to seven in number.

MEADOW LARK.

(Plate 2, Fig. 14.)

The Meadow Lark is common from the Atlantic to the Great Plains, and a variety extends west of the Plains to the Pacific Coast. It is an inhabitant of both prairie land and fields in districts more or less wooded, and while not a fine songster, in the opinion of many, adds much to our enjoyment of the country. The color of the upper parts is a mingling of black, whitish and chestnut, darker on the head, where we find a light streak running back from the bill; side of head light, showing a yellow streak over and in front of eye; chin, throat, and breast bright yellow, with a jet black

collar or cravat on breast in form of a crescent; all but the central tail feathers showing considerable white. Length, ten to eleven inches. It nests upon the ground. Analyses of stomach contents give interesting results: Two hundred and thirty-eight stomachs examined contained seventy-three per cent animal matter, and twenty-seven per cent vegetable, the latter being found in the winter. The animal food consisted of insects of ground species—beetles, bugs, grasshoppers, caterpillars, and a few flies, wasps, and spiders. A number of the stomachs were taken from birds killed when the ground was largely covered with snow, but still contained a large percentage of insects. Crickets and grasshoppers constitute twenty-nine per cent of the entire year's food, and sixty-nine per cent of the food in August. Twenty-one per cent of beetles was found, of which about one-third were predaceous ground beetles; the others all harmful species. In May caterpillars constitute over twenty-eight per cent of the whole food, with a large number of cutworms. Grain makes up fourteen per cent, and weed and other seeds, twelve per cent.

MARYLAND YELLOW THROAT.

(Plate 3, Fig. 15.)

This beautiful warbler is one of the most attractive of the family. It perhaps is not as useful as many others because of its somewhat shy habits and the environment of its nest. It is, nevertheless, thoroughly insectivorous and as such, and because of its beauty, entitled to our friendship. The male has a jet black band across forehead and over the cheeks; remainder of upper parts and tail, olive green; throat and chest, bright yellow. Nests frequently on the ground; eggs, white, speckled. Found throughout the United States east of the Great Plains. We have found it common in the Red River Valley. It may be regarded as fairly common throughout most of Minnesota, but not conspicuous on account of its retiring habits.

CEDAR BIRD: CEDAR WAXWING, OR "CHERRY BIRD."

(Plate 3, Fig. 16.)

This beautiful bird is about seven inches long, the tips of the secondary feathers in wing and frequently the tail feathers with tips resembling red sealing wax; hence the above name. The head and upper parts, a warm grayish brown; a conspicuous crest; a jet black line across forehead and through eyes; a yellow band across tail at its end; yellowish below.

It is found in varying abundance over the United States and breeds throughout its range. The nest is characteristic, rather bulky but of loose construction, in which rootlets, moss, twigs, and lichens may appear, and is found in fruit trees or shade trees from six feet to fifteen or more above the ground. Eggs have been described as "putty colored." There may be three, four, or five in a clutch and irregularly spotted with black or brownish markings. These birds are fond of canker worms and other caterpillars and are valuable allies in any orchard. One year in August I noted in the Red River Valley a fly-catching habit of this bird and find the following entry in my notes: "For almost half an hour, I watched six of these birds, constantly on the wing, hovering over a slough and catching quantities of (these) insects. They seemed never to grow tired, but flew slowly against the wind, deviating now a little to this side, now to that, until they reached the end of the slough, when back they came to repeat the same manœuvre and go over the same ground again and again. Occasionally, they uttered the characteristic note of the species, but, for the most part, flew silently. During the time I stood watching them, they did not once rest."

CHESTNUT-SIDED WARBLER.

(Plate 3, Fig. 17.)

An attractive insect-eating summer resident, typical of the large family of warblers, a goodly number of which either pass through Minnesota in spring and fall, or nest here. A male bird is figured,—crown, yellow; sides of breast, chestnut; and some greenish yellow in the black of the upper parts; below, white; length, about five inches. It reaches Minnesota about the middle of May.

CROW BLACKBIRD; PURPLE CRACKLE.

(Plate 3, Fig. 18.)

Eats white grubs, grasshoppers, and other insects including army worms but capable of doing damage in grain fields when present there in large flocks. It is at such times that a farmer is justified in protecting his crops by the judicious use of the shotgun. But the bird should not be classified as an enemy to the farmer because it is also known to do good as indicated above. It is unfortunate that the engraver should have placed the bluebird's head, with its contrasting blue, so close to the head of the blackbird. This inharmonious grouping came to the notice of the writer too late for correction. The crow blackbird is twelve inches long,

builds a coarse nest of grass and mud, frequently in evergreens, or even in niches in the cornices of public buildings. We have found them as far north as Otter Tail County the latter part of October.

BLUEBIRD.

(Plate 3, Fig. 19.)

Too well known to need detailed description. Found through the United States, Canada, Mexico, and parts of Central America. Upper parts, including wings and tail, bright blue; breast, throat, and sides, reddish. Length, seven inches. It is of wide distribution, from the Atlantic to the Rockies, and from Canada to the Gulf of Mexico. Its note is among the first to be heard in the spring, and one of the last in the fall, at which latter time we associate it with the falling leaves of Indian summer. To the writer, its note in the fall has always appeared to take on additional sadness, as though lamenting the dying of the year. It nests in hollow trees and in boxes erected in suitable places, and should be encouraged by providing it with plenty of such opportunities for housekeeping. An examination of two hundred and five stomachs showed that seventy-six per cent of the food consisted of insects and their allies, while twenty-four per cent is made up of vegetable substances. Beetles constitute twenty-eight per cent of the whole food; grasshoppers, twenty-two; caterpillars, eleven; and various insects, including spiders, comprise the remainder of diet. All these insects are more or less harmful, except a few predaceous beetles, which amount to eight per cent. Prof. S. A. Forbes of Illinois examined one hundred and eight specimens secured in every month except November and January, and results of these examinations prove that although the bluebird eats some insects which are beneficial, and occasionally takes a raspberry or gooseberry, it consumes such an immense number of injurious insects, cut worms, and army worms, moths grasshoppers, and crickets, that it is undoubtedly a beneficial bird. Nestlings of the bluebird, like the young of almost all of our common birds, are fed an enormous quantity of insects. These birds have been known to arrive in the vicinity of Minneapolis as early as January, but generally they need not be looked for until late in March. They remain with us until late in October and occasionally into November.

BLACKBURNIAN WARBLER.

(Plate 3, Fig. 20.)

A beautiful representative of the warbler family and a strictly insectivorous bird, though breeding as it does in the evergreen woods, it consumes more insects there than it does in the neighborhood of farms. However, even the warblers that pass through this latitude in spring and again in the fall, not nesting here, are useful, in that they are keen hunters of insects found in our trees at that time. The Blackburnian warbler is hardly to be regarded as a common bird in Minnesota and it seems quite natural in view of its gaudy colors that it should winter in the tropics. It is about five and a quarter inches in length, and the male, strikingly colored, is indicated in the illustration. The back is streaked with black and white and the deep orange shown in the figure extends over the chin, throat, and breast; under parts are tinged with the same color. Regarded by many as the most beautiful of all the warblers.

ROSE-BREASTED GROSBEAK.

(Plate 3, Fig. 21.)

This beautiful bird and excellent songster is common in almost all parts of Minnesota, the male at once recognized by the striking black and white coloration and beautiful rose coloring of breast and under side of wings. The female is brownish or olivaceous and in her the rose of the male is replaced by yellow. As the name indicates, the bill is strikingly large and, even without the above colors, would be sufficient to distinguish these birds from other summer bird residents. This species is found breeding as far north as southern Canada and throughout its range is a help to the agriculturist. It occasionally eats peas and a little fruit, but consumes an enormous number of potato beetles as well as striped cucumber beetles. It is reputed as attacking scale insects and the writer has seen it foraging for grasshoppers. Canker worms, tent caterpillars, army worms, cut worms, chinch bugs, and others are known to be included in its dietary. This grosbeak is about eight inches long; nests from five to fifteen feet or more from the ground; eggs, four or five, light blue with irregular brownish markings. Reaches Minnesota generally about the first week in May, though it has been noted here the latter part of April. In the Red River Valley we have found them common in wooded sections.



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Plate 3.

The above list is far from complete but it is fairly representative and we have not finances and consequently not sufficient space to make it more extensive.

We might add the following common and also beneficial birds: House Wren, nearly 100 per cent of its food being insects, reaching Minnesota about April 25th; the Barn Swallow, which captures, while on the wing, moths, flies, beetles, and frequently grasshoppers (house bedbugs, contrary to a very common belief, are **not** found in swallows' nests); the Purple Martin, an excellent addition to any farm: should be provided with martin houses and its presence encouraged. It wages relentless war upon hawks and crows and constitutes therefore a guard for poultry and small birds. In the writer's notes on Minnesota birds occurs the following entry regarding the Purple Martin, resulting from an ornithological trip through the Red River Valley some years ago: "This species, too, occurs about Mille Lacs, where the farmers provide boxes for them. The great majority of them there, however, nest with the gulls on an island called Spirit Island by the Indians, lying about two miles from the southeastern shore of Lake Mille Lacs. Here large numbers lay their eggs in the crevices and fissures of the rocks and serve as allies in driving away the ravens and other birds disposed to prey upon the eggs and young of the gulls." This bird appears to be growing rarer in Minnesota, due perhaps to lack of provision in the way of bird houses.

The Song Sparrow, so dear to us all, deserves a prominent place on our list; it is not only friendly and attractive because of its song and from the fact that it is one of the earliest of bird arrivals from the South, but it consumes a large amount of weed seed and many insects. The food of the Night Hawk also appears to be May flies, dragon flies, beetles, gnats, ants, and frequently potato beetles, grasshoppers, etc.

The Yellow Hammer or Flicker, we purposely left off the colored plate, to allow space for a more useful woodpecker. The Flicker or High Hole is something of a "ground bird;" that is, it is very fond of ants and is quite apt to be discovered dining on ants upon the ground. It eats wood-boring grubs to some extent, but is not as industrious in that direction as many of our other woodpeckers. It occasionally takes a little fruit and is reported to eat grain, though rarely. On the whole, it is a useful bird, and we are attached to it because we associate its characteristic call with

the promising days of early spring before the leaves appear on the trees.

The Ruby-crowned and Golden-crowned Kinglets, tiny denizens of woodlands, consume large quantities of beetles, bugs, tree hoppers, scale insects, plant lice, and leaf hoppers.

It is unfortunate that the Mourning Dove or Ground Dove is included amongst our game birds, as it deserves protection. A bulletin from the United States Department of Agriculture (Farmers' Bulletin 513, Bureau of Biological Survey) reports the finding in one stomach of seventy-five hundred seeds of yellow wood sorrel; in another sixty-four hundred seeds of foxtail, and in a third twenty-six hundred seeds of slender *poa*, forty-eight hundred and twenty seeds of orange hawkweed, nine hundred fifty of hairy vervain, one hundred twenty of Carolina cranesbill, fifty of yellow wood sorrel, six hundred twenty of panic grass, and forty miscellaneous weed seeds.

Amongst our game birds, the Quail gets most of its grain after the crop has been gathered; it eats insects, some of them very injurious; large numbers of potato beetles and chinch bugs have been found in its crop; army worms, cut worms and wire worms form a portion of its diet. It appears to be growing more abundant in the State from year to year, and working farther north each season, yet its occurrence in any latitude in any year naturally depends upon the severity of the preceding winter and upon general climatic conditions.

The Killdeer or Ringneck Plover, common in low-lying fields and frequently seen about the barnyard, easily recognized not only by its rather plaintive note but particularly by the black band across the white breast, consumes the larvae of many injurious insects found in pastures and meadows; it eats wire-worms, caterpillars, grasshoppers and crickets and the eggs of the two latter.

The Black Tern, found so abundantly about our prairie sloughs, and the most abundant representative of the group in Minnesota, is a good friend of the farmer, for when the sloughs are dry, and even before, they consume large numbers of grasshoppers. Amongst others of this family (gulls), Franklin's Rosy Gull is one of the chief breeders within the State's borders and is a voracious eater of grasshoppers.

BAD BIRDS.

Under this head, we would unhesitatingly place the Sharp-shinned Hawk, Cooper's Hawk and Goshawk, the chief marauders against poultry and small birds; the Yellow-bellied Woodpecker, or "Sap-sucker," which feeds upon the sap of trees, leaving rows or holes about the trunks, and the English Sparrow, or more correctly speaking, the European House Sparrow.

The Sap-sucker (the only bad woodpecker we have) preys upon birch, maple, apples, mountain ash, evergreens, and other trees. Some of the cambium or inner layer of bark is eaten also. While this bird eats a few insects, the damage it does in causing trees to bleed, far outweighs the benefits derived from its presence.

The English Sparrow, too, eats some insects, but its noisy chatter, filthy habits, and pugnacious disposition make it an undesirable bird member of any community.

BIRDS OF DOUBTFUL UTILITY.

Amongst doubtful birds, we place with reluctance our friend the Cat-bird. Although having a delightful song, equal or surpassing that of the Brown Thrush in our estimation, it nevertheless is not of valuable assistance to the gardener or farmer. It eats some insects, it is true, but in the latter part of June "these insects were largely replaced by cherries, currants, raspberries, and strawberries. Three-fourths of the food of eleven July catbirds consisted of small fruits, mostly (64%) blackberries. Nine percent of beetles had been taken, most of them being predaceous (beneficial)." (From observations by Forbes of Illinois in "Birds in Their Relation to Man," by Weed & Dearborn.) Nevertheless, on account of its song and friendliness and from the fact that it does consume some injurious insects, the cat-bird will doubtless continue to be protected except in cases of particularly flagrant destructiveness.

The Crow and the various blackbirds will at times call for radical treatment. The writer has seen both crows and blackbirds hunting grasshoppers in stubble fields and both are known to eat other insects, yet their food habits are such as to make their constant protection undesirable and, when necessary, the farmer should not hesitate to resort to extreme measures to protect his crop.

Like the Crow, our Bluejay sometimes robs birds' nests of both eggs and young birds. However, since he is something of an

insect eater, and only occasionally resorts to corn or other grain, it would be hardly just to make war upon him.

Interesting and valuable publications upon this subject are Chapman's "Bird Life" (not economic), Appletons publishers; "Birds in Their Relation to Man," by Weed and Dearborn, Lippincott; Chapman's "Handbook of Birds of Eastern North America;" synoptical and descriptive; very helpful in identification, Appleton & Co.

Amongst larger works, perhaps not so easily accessible to the amateur are Coues' "Key to North American Birds;" Baird, Brewer & Ridgway's "North American Birds;" several publications of the Department of Agriculture, for the most part out of print now, and somewhat antiquated; and more recently Farmers' Bulletin No. 531 (U. S. Bureau of Biological Survey) "Fifty Common Birds" with colored illustrations (out of print); and a helpful publication upon "Bird Houses and How to Build Them," by Dearborn—Farmers' Bulletin No. 609, Sept. 11, 1914.

In the United States Yearbook for 1909, pp. 185-196 (Yearbook Separate No. 504) occurs an interesting article by McAtee on "Plants Useful to Attract Birds and Protect Fruit."

PROTECTION OF PLANTED CORN FROM CROWS AND OTHER ANIMALS.

Corn, after being planted, is subject to the attacks of a few animals which cause loss to the farmer. Chief among these at times is the crow, and any treatment given the seed to protect it from the attacks of this bird, will, at the same time, afford protection against a few insects which occasionally eat the seed, and also reduce the loss from striped squirrels, gophers, and kindred four-footed creatures.

We have found that white twine about the edges of a corn field, strung on high poles, and hung with strips of tin (one about every thirty feet), white rags, etc., to be an excellent device in keeping crows away from a planted field. If, in addition to this, a few dead crows are suspended from high poles in different parts of the field, the combination of white twine, bright tin shining in the sun, and the dead crows as a warning to would-be evil doers, works so well that the farmer may rest assured it will be many days before his field is touched by these marauders. This remedy, or the twine alone, by the way, is in quite general use today.

Crows can be poisoned by dissolving ten cents worth of sulphate of strychnine in enough hot water to soak up two quarts of corn. This should be scattered about the field where crows are working late in the evening that they may find it there in the early morning.

If scarecrows are used they should be changed occasionally. Forbush in "Useful Birds and Their Protection," advises the use of a barrel hung on a leaning pole.

One of the safest and best ways of tarring corn and yet not affecting its use in a planter is one originating in Massachusetts. "Put one-fourth to one-half bushel of corn in a half-barrel tub; pour in a pailful of hot water, or as much as is necessary to well cover the corn; dip a stick in gas tar and stir this briskly in the corn; repeat until the corn is entirely black; pour off on to burlap (bran sacks are good); spread in the sun and stir two or three times during the day. If this work is done in the morning and the day is sunny, the corn will be ready for the planter the next day without any other care." A machine will easily handle corn treated in this way. Another way is as follows: "Put corn in fertilized sack, pour (thinned) tar on corn, tie the sack; let the boys tumble the sack about; add ashes or land plaster; tie sack, tumble some more and it is ready for the planter." The gas tar can be and should be diluted with linseed oil.

Deep planting, three or four inches, will, in some heavy soils, discourage the crow.

If one is a good enough shot with a rifle, and can pick off a crow or two at long range, the birds keep away from a field so protected. Even if not hit they seem to realize that it is dangerous ground. Any birds killed should be hung up in the field.

REPORT ON INSPECTION OF MINNESOTA NURSERIES AND OF IMPORTED NURSERY STOCK AND ORNAMENTALS 1913-1914*

F. L. WASHBURN.

The nursery industry of Minnesota is rapidly assuming proportions which places the State amongst the front ranks as a producer in this line. The nurseries of the State represent now one of our large industries, rapidly increasing in size, due to the increasing prosperity and the growing civic spirit of our citizens. The increase in the amount of work involved in inspection has been most striking. In 1903, only 25 certificates were issued; in 1913, we issued 101 certificates, and in 1914, the number has increased to 117, 51 more than were issued in 1912. The total area in Minnesota devoted to the growing of nursery stock approximately totals 3,000 acres, represented by about 130 nurseries. It is to be noted that all of these do not receive certificates. They are all inspected, but some do not ship, and therefore we save them the \$5.00 fee by not issuing certificate.

In view of the above mentioned facts, and the splendid stock and large assortment of varieties of hardy fruit trees, shade and ornamental, grown by our Minnesota nurserymen, it would seem not amiss to urge our citizens to plant Minnesota grown stock.

The increase in importation of foreign stock and the consequent inspection of same, have kept pace with that of domestic inspection. In 1913 we inspected 439 cases, representing about 10,000 azaleas, 3,500 roses, 2,500 hydrangeas, 235 palms, and enough other miscellaneous and ornamental shrubs to total approximately 100,000 plants. Bulbs we do not inspect, as the labor involved would require an enormous outlay of both money and time, and the few pests at all likely to be introduced, for the most part already exist in this country.

Under the conditions of a law enacted by Congress, the importer, when foreign stock is received at the port of entry, is obliged to notify the inspector in the State to which the consignment is to be

* Also printed as Circular No. 31.

shipped, stating probable date of shipment to the ultimate consignee. Upon receipt of this notice, or an equivalent notice from the Federal Quarantine Board, the Entomologist notifies the consignee in Minnesota, requesting him to advise this office of the date of the probable receipt of said stock, or that he notify us immediately upon its arrival, so that it may be inspected at once. Under the Federal law the secretary of the Horticultural Board at Washington also receives a notice of each consignment and he mails a Federal notice to the Entomologist in duplicate. Thus we are enabled to check up all shipments, and after stock is inspected here, the original Federal blank is filled out and sent to Washington.

It is necessary that Minnesota work in coordination with the Federal government, and largely with that intent, the new State law, a copy of which we print herewith, was passed and became effective in 1913. The State Entomologist regards this State law in a purely impersonal way. He is simply the instrument for carrying out its provisions and is not at liberty to make exceptions or disregard its instructions. He is not in the slightest degree responsible for its effect upon any individual, or individuals. At the same time he believes that all interested will unite in saying that it is on the whole a good law, and necessary to prevent spread of pests from place to place within the state, and the introduction of any pests into the state. Occasionally it is possible the law, as worded, works a hardship, but on the whole, we are, or should be, willing to make some sacrifice for the common good, and the public at large cannot always be best served without embarrassment to some individuals—fortunately only a comparative few. All nurserymen, as well as the Entomologist, desire to see Minnesota's standard, in the line of nursery stock, upheld, and none of us want to see the introduction into the state of the Gypsy or Brown-tailed Moth, the Elm-leaf Beetle, the San Jose Scale, or the White Pine Blister Rust and other destructive plant diseases. Further, a good system of inspection is a guarantee to other states that Minnesota puts reliable stock on the market.

With a limited number of assistants, at times in fact reduced to one man, and frequently with several large shipments arriving simultaneously from Europe, it is sometimes impossible to respond to all telephone calls, requests by mail, and telegrams from different firms asking us to "come immediately, stock must be unpacked." When this emergency arises, although the law definitely states that shipments from abroad shall not be unpacked before the arrival

of the inspector, we sometimes, in order to prevent the plants spoiling, allow florists and nurserymen to unpack consignments with the understanding that plants (shrubs or vines) and containers as well, must remain in greenhouse or packing shed until the arrival of the inspector, and we further request that the labels must be left intact on boxes in order that we may check up with notice from Washington, and that all packing material in said boxes must be immediately burned. Consignees understand that permission to do this must be secured from the State Entomologist **in each case**, since it is a courtesy extended to insure the safety of the plants. Any one presuming that it can be done at any time without the above permission is liable to prosecution and fine, as provided for in the State Law.

In this connection it is an interesting fact that up to this date (November 10, 1914) consignments of azaleas have been arriving from Belgium in the usual number, in spite of the terrible conditions which must have prevailed there this fall, at the time of packing. We have already examined about 16,000 azaleas from that country. One consignment was sent from a Belgian town near Ghent, and upon the Belgian certificate appeared the inspection date of September 15th. Another Belgian inspection was made September 24th; shipments being made, of course, subsequent to those dates. We have also been notified of the arrival of shipments from Holland consisting of hydrangeas, roses, begonias, etc.

Mr. A. J. Spangler was our chief inspector in the field during 1913 and rendered excellent service. His work evidenced a high degree of efficiency, and his experience in this line, before he came to Minnesota, was such as to make his work here a real help, not only to the inspection force but to the nurserymen with whom he came in contact. During the season of 1914 he has been away on leave, and his place has been filled temporarily by Mr. G. W. Peake, also an efficient and acceptable worker in this field of activity.

Condition of Minnesota Nurseries and Certificates Granted in 1913:

The season was, on the whole, a favorable one for tree growth, and for the most part, all nurseries appeared to be in good condition. During the summer there was considerable rainfall, causing a rank growth of weeds and calling for assiduous cultivation on the part of those who would keep their nurseries clean.

The most abundant and injurious insects were the apple leaf-hopper, *Empoasca mali*, the striped poplar beetle, *Melasoma scripta*,

and the apple aphid. According to Mr. Spangler's record on field work, the apple leaf-hoppers were very abundant and in many cases severely checked the growth of large blocks of apple trees. This pest has been always with us. One nurseryman who had been very much troubled with the leaf-hopper had been in the habit of propagating from an old scion block severely infested by this insect, but is now starting a new orchard from which scions will be cut in the future. (NOTE: In the fall the apple leaf-hopper lays its eggs in the new twigs and branches of the apple, and scions being made from these, the pests are carried to new fields. F. L. W.)

The increasing acreage devoted to the growth of poplar and willow cuttings has apparently had a similar effect on the number and severity of attack of the striped poplar beetle. This insect is now present in every nursery growing its host plant. It is a voracious feeder and if the trees are not sprayed upon its first appearance, becomes hard to control.

Of plant diseases, the most injurious and most prevalent was crown gall. We also found anthracnose on raspberry, and Mr. Spangler reported leaf rust on poplar and ash.

Quoting again from his report on field work: "Crown gall is present in a greater or less degree in every nursery. The effect of this disease on the growth of apples in the nursery row, is not always marked and the only way to ascertain its presence is to dig or pull up the trees. This, at best, is an unsatisfactory and unscientific procedure. An inspection at the time the trees are dug in the fall or packed in the spring is the only scientific method. However, such an examination would be prohibitive considering the number of nurseries, and until it can be shown that the disease is more decidedly injurious to the apple, the present policy of warning the nurserymen to cull out the affected trees when dug, would seem the best solution of this problem." It is believed, although crown gall may not affect the apple injuriously, that the soil where crown gall stock of any kind is grown, is so thoroughly inoculated with this disease, that any stock whatever subject to galls planted thereon, either with the affected stock standing in close vicinity or planted immediately following the removal of the diseased stock, would be seriously affected. For example, it is probable that nursery rows of apples planted between the trees of a young orchard infested with crown gall, would become in turn seriously affected.

In the case of raspberries, however, this being a plant of rapid growth, crown gall is very injurious, and is so recognized. An

infestation of 20% is considered a sufficient cause for ordering the removal of plants so affected. In one nursery it was known to destroy all of one variety, and in several cases when young plants were badly affected, they were allowed to stand for this season (1913) for fruiting purposes only. Anthracnose on raspberries was found in injurious amounts in two nurseries. The varieties susceptible to this disease are propagated by tip-layering and if the parent cases are removed, the disease seldom becomes serious.

Leaf rust of poplar and ash trees and the tar spot on maple seem very general in the older and larger nurseries, but since this disease exists on the native trees, their presence in the nursery row is not surprising.

MINNESOTA INSPECTED NURSERIES. 1913.

Certificate Number	Nursery	Town	Date of Expiration 1914
552	The Albert Lea Nursery Co. C. M. Peterson	Albert Lea	July 27
579	The Minnesota State Nursery E. C. Eaker	Albert Lea	July 27
553	The South Side Nursery Martin Fridholm	Albert Lea	July 27
563	The Wedge Nursery Clarence and Robert Wedge	Albert Lea	Aug. 15
584	The Askov Nursery Ludvig Mosback	Askov	Sept. 16
554	The Turtle Creek Nursery J. M. Lindsay	Austin	July 29
555	The Austin Nursery C. F. Woodlee	Austin	July 29
523	The Battle Lake Nursery A. A. DeSmidt	Battle Lake	July 3
524	The Itasca Park Region Nursery Co. L. P. Anderson	Bemidji	July 12
573	The Byron Nursery F. E. Cutting	Byron	Aug. 28
519	Oslund's Nursery N. N. Oslund	Cambridge	Oct. 1
539	Sivert's Nursery Peter Sivert	Canby	July 20
580	The Fillmore County Nursery Geo. F. Snyder	Canton	Sept. 8
529	The North Star Farms J. W. Beckman	Cokato	July 17
530	The Wright County Nursery Co. John Eklof	Cokato	July 17
531	The Cokato Berry Farm A. L. and F. Lee	Cokato	July 17
506	The Redpath Nursery Thomas Redpath	Crystal Bay	June 12
536	The Flyen Nursery Henry Flyen	Dawson	July 22

510	The Deephaven Nursery.....	Deephaven	June 12
	Alfred O. Hawkins		
571	The Deerfield Nursery.....	Deerfield	Aug. 27
	J. F. Brady		
11	(Dealers) The Duluth Floral Co.....	Duluth	Sept. 19
525	East Grand Forks Nursery.....	E. Grand Forks.....	July 17
	Oscar Wick		
509	Old Fashioned Flower Garden.....	Excelsior.....	June 14
	Mrs. M. S. Sawyer		
503	A. Brackett.....	Excelsior	April 28
547	The Amber Lake Nursery.....	Fairmont	July 24
	P. C. Christenson		
548	McKisson's Fairmont Nursery.....	Fairmont	July 24
	G. D. McKisson		
1	(Dealers) Royal Nursery Co.....	Fairmont	Aug. 17
	Fred Ward		
546	The St. John's Nursery Co.....	Fairmont	July 23
	B. E. St. John		
577	The Faribault Nursery Co.....	Faribault	Aug. 17
	A. M. Brand & Co.		
569	The Farmers' Seed and Nursery Co.....	Faribault	Aug. 26
	Wm. Kueker		
589	The Andrews Nursery Co.....	Faribault	Aug. 27
	John P. Andrews		
522	The H. Koppe Nursery.....	Fergus Falls.....	June 28
	Hugo Koppe		
501	The Mills Lake Nursery.....	Garden City.....	July 27
	L. D. Mills		
585	The Lake View Nursery.....	Grayling	Sept. 21
	Victor Carlson		
594	Hiawatha Gardens Nursery.....	Hamel	June 25
	Hiawatha Gardens Co.		
527	Hugart & Sons Nursery Co.....	Hamel	July 15
	H. F. Hugart		
528	Howard Lake and Victor Nurseries.....	Howard Lake.....	July 15
	W. H. Eddy		
537	Christensen's Nursery.....	Hutchinson	July 24
	P. Christensen		
544	Harry Arp.....	Jackson	July 22
538	Dewain Cook.....	Jeffers.....	Oct. 7
559	The Kenyon Nursery.....	Kenyon	Aug. 1
	J. A. Mogren & Son		
558	The Oak Grove Nursery.....	Kenyon	Aug. 1
	P. H. Volstad		
586	Ayers Jack Pine Nursery.....	Kimberly	Sept. 22
	H. B. Ayers		
534	Kenyon's Riverside Nurseries.....	Lamberton.....	July 21
	J. M. Kenyon		
565	The Jewell Nursery Co.....	Lake City.....	Aug. 20
	J. M. Underwood		
567	The National Nursery Co.....	Lake City.....	Aug. 21
	J. F. Anderson		
564	The Sugar Loaf Valley Nursery Co.....	Lake City.....	Aug. 21
	Moseman Bros.		
3	(Dealers) The Johnson Nursery.....	Lake City.....	Aug. 21
	P. G. Johnson		
568	Tolleson's Nursery Co.....	Lake City.....	Aug. 21
	G. A. Tolleson and A. V. Wickstrom		
581	The Mayfield Nurseries.....	Lakeland	Sept. 9
	L. L. May & Co., St. Paul		
590	The Oak Valley Fruit Farms.....	LeRoy	Aug. 30
	H. W. Harrison		

513	Chisago Lake Nursery.....	Lindstrom	June 24
	Ludwig Carlson		
521	Morrison County Nursery.....	Little Falls.....	July 27
	C. Kelly & Sons		
526	Minnetonka Nursery.....	Long Lake.....	May 26
	J. D. Winter		
505	The Tong Nursery.....	Long Lake.....	May 26
	Geo. Tong		
543	The Luverne Nursery.....	Luverne	July 18
	C. E. Older		
533	The Madison Nursery.....	Madison	July 19
	M. Scholt		
541	The Mankato Nursery.....	Mankato	July 16
	L. Z. Smith		
2	(Dealers) M. M. Sinotte.....	Mankato	Sept. 9
572	The Dodge County Nursery.....	Mantorville	Aug. 28
	W. E. Fryer		
520	The Orton Park Nursery.....	Marietta	June 22
	C. J. Orton		
570	The Medford Nursery.....	Medford	Aug. 27
	C. C. Patten		
571	The Deerfield Nursery Co.....	Medford	Aug. 27
	C. H. Brady		
517	H. F. Baker.....	Minneapolis	June 21
	4629 Lake Harriet Boulevard		
591	Farmer's Nursery and Fruit Farm.....	Minneapolis	Oct. 1
	E. A. Farmer		
508	The Franklin Nursery.....	Minneapolis	June 18
	A. B. Franklin		
576	Charles Hawkinson.....	Minneapolis	June 14
575	C. C. Hunter & Co.....	Minneapolis	June 18
4	(Dealers) The Minneapolis Nursery....	Minneapolis	Sept. 12
	A. Norlander		
8	(Dealers) Northrup King & Co.....	Minneapolis	Oct. 14
592	The Ritchell Berry Farm.....	Minneapolis	Sept. 12
	W. Ritchell		
512	The Rose Hill Nursery.....	Minneapolis	June 17
	John Hawkins		
3	P. G. Johnson.....	Mpls. (Lake City)....	Aug. 21
511	Vine Grove Nursery Co.....	Minneapolis	June 17
	A. M. Shepard & Son		
532	Tieglund's Nursery.....	Minneota	July 19
	J. L. Tieglund		
504	G. R. Widger.....	Monticello	April 30
6	(Dealers) The New Ulm Greenhouses...	New Ulm.....	July 15
	Chris Boock		
540	The Pioneer Nursery.....	New Ulm.....	July 15
	Wm. Pfaender		
560	The Northfield Seed and Nursery Co....	Northfield	Aug. 9
	J. M. Punderson		
518	Dunsmore Nursery.....	Olivia	June 28
	Henry Dunsmore		
566	Clinton Falls Nursery Co.....	Owatonna	Aug. 13
	T. M. Cashman		
561	The Mitchell Nursery Co.....	Owatonna	Aug. 14
	D. M. Mitchell		
562	The Owatonna Nursery Co.....	Owatonna	Aug. 14
	L. S. Wesely		
516	The Elmwood Select Nursery.....	Paynesville	June 28
	Frank Brown & Son		
583	O. J. Graham.....	Pine City.....	Sept. 16

10	(Dealers) Plainview Nursery.....	Plainview	Aug. 2
	R. W. Chapman		
556	The Preston Nursery.....	Preston	July 30
	C. E. Snyder		
587	J. V. Bailey's Nursery.....	Red Rock.....	Sept. 30
	J. V. Bailey		
574	The Vinegar Hill Nursery.....	Rushford	Sept. 2
	Wm. Sandrock		
535	The Sacred Heart Nursery.....	Sacred Heart.....	July 22
	J. T. Flagstad & Son		
542	John Hill.....	St. James	July 17
514	The Park Nursery.....	St. Paul.....	June 26
	Holm & Olson		
578	Hoyt Nursery Co.....	St. Paul.....	June 13
	B. T. Hoyt		
581	L. L. May & Co.....	St. P. (Lakeland)....	Sept. 9
9	The Minnesota Northern Nursery Co..	St. Paul.....	Oct. 27
	J. E. and E. C. Killmer		
588	The Nicollet County Nursery.....	St. Peter.....	July 10
	C. E. Swanson		
545	L. Meininger.....	Sherburne	July 23
507	The Ferodowill Nurseries.....	Spring Park.....	July 19
	F. X. Ferodowill		
515	The Fairview Nurseries.....	Stillwater	June 26
	Frank Berry		
582	G. W. Strand.....	Taylor's Falls.....	Sept. 15
7	(Dealers) The Tyler Nursery.....	Tyler	Oct. 4
	J. P. Ericksen		
507	F. X. Ferodowill.....	Wayzata	June 19
510	The Deephaen Nursery.....	Wayzata	June 12
	A. C. Hawkins		
576	Charles Hawkinson.....	Wayzata	June 14
557	The West Concord Nursery.....	West Concord.....	Aug. 1
	F. J. Cowles		
550	S. D. Richardson Nursery.....	Winnebago City....	July 24
549	Winnebago Nursery.....	Winnebago City....	July 24
	John Van Blair		
502	The University Fruit Farm Nursery....	Zumbra Heights....	April 12
	State of Minnesota		

A summary of the moneys collected as fees for the Nursery Inspections as provided by Sections 1 and 7 of the Nursery Inspection Act is as follows:

July 3, 1913	State Treasurer's Receipt No. 874.....	\$ 98.00
July 31, 1913	State Treasurer's Receipt No. 981.....	120.00
Aug. 6, 1913	State Treasurer's Receipt No. 993.....	55.00
Aug. 6, 1913	State Treasurer's Receipt No. 1909.....	228.00
Nov. 29, 1913	Cash on hand.....	5.00
		<hr/>
		\$506.00
89	Nursery Inspection Fees....	\$5.00.....\$445.00
8	Special Inspection Fees....	5.00.....40.00
2	Inspection Fees (affidavits not yet filed)	\$5.00....10.00
2	Inspection Fees due 1912, paid 1913.....	11.00
		<hr/>
		\$506.00

The new law requiring all fees collected to be turned into the State Treasury, did not become effective until August, 1913, and hence all money collected in 1913 previous to that time (\$454.99) were credited by the State Auditor to the Entomologist's fund and

used in carrying on the work. The total receipts from certificates of inspection in 1913 were \$506.00. We hold State Treasurer's receipts Nos. 874, 981, 993 and 1909 for \$501.00, which was turned into the State, \$464.99 of this being credited to the State Entomologist fund as before stated. One \$5.00 fee was received too late to be listed in 1913, and was credited on the 1914 account.

Legislation in 1913.

In the early part of the Legislative session of 1913, a new nursery and orchard inspection law was passed, making inspection compulsory, establishing a flat fee of \$5.00 for each certificate granted, and articulating with the provisions of the new Federal quarantine laws. A copy of the State law is here appended.

STATE OF MINNESOTA

Chapter 206, Session Laws of 1913

AN ACT PROVIDING FOR THE INSPECTION OF NURSERIES AND ORCHARDS.

Be It Enacted by the Legislature of the State of Minnesota:

Section 1. **State Entomologist Designated Inspector of Nurseries—Fees—Powers and Duties.**—That the State Entomologist is hereby designated as State Inspector of nurseries and is authorized, either himself or by deputies duly appointed by him, to inspect all premises in Minnesota where nursery stock is grown or held for sale, and further to inspect all orchards or any premises whatsoever within the State, where he has reason to suspect the presence of injurious insects or injurious and contagious plant diseases. Nursery stock shall be regarded as including all field-grown plants (except herbaceous annuals) of any kind, also trees, field-grown shrubs, vines, cuttings, buds, grafts and scions. For this purpose he or his deputy or deputies shall have free access to any field, ground, packing ground, buildings, cellars and other places where the carrying out of the provisions of this act shall make necessary. The State Inspector of Nurseries is empowered and required to grant certificates upon request to such nurseries as he may find free from injurious insects and contagious plant diseases. Such certificates shall be good for one year unless revoked by him. This inspection of nurseries shall take place between May 1st and September 30th, and at such other times as may be necessary to comply with the provisions of this act. Nurserymen or others having stock to inspect shall make application to the State Nursery Inspector for the inspection of stock as far as practicable on or before May 1st of each year. It shall be the duty of the inspector or his deputy to make the inspection as soon thereafter as possible.

For inspection of nurseries a fee of \$5.00 per annum shall be paid at time of inspection or before certificate is granted. If a dangerous insect pest or plant disease is found by the inspector on the premises above described and if in his judgment such pest or disease can be eradicated he may direct the owner or his representative in writing what means shall be employed; in case any trees, shrubs or plants are so infested that treatment would be ineffectual he may direct the owner or his representative to have them destroyed. Said order shall be issued in writing. If the order be not obeyed within ten days after service thereof, the State Inspector shall

cause the work to be done and render to the owner or persons in charge an itemized bill of the cost; and if such cost shall not be paid within sixty days thereafter the bill shall be reported to the County Attorney who shall forthwith collect same in a civil action in the name of the state and shall turn same over to the State Treasurer to be credited to the inspection fund.

Sec. 2. Nursery Stock Brought Into the State Must Be Certified To.—No person shall bring into the State for sale or use therein or re-shipment any trees, plants, vines, cuttings or buds or other "Nursery Stock" unless it be accompanied by the certificate from the Inspector or other proper official of the State from which it came, that it has been inspected and found free from any of the pests or diseases referred to. Such certificates shall be prima facie evidence of the facts therein stated but the Entomologist may if deemed necessary, inspect such stock and proceed with respect thereto as provided for in Section 1.

Sec. 3. Copy of Certificate to Be Filed With Minnesota Inspector.—A copy of the state inspection certificate granted to any firm or firms in any other state, territory, or the district of Columbia, shall be on file with the Minnesota inspector before any such firm or firms shall make shipment of nursery stock to be sold or distributed in the State of Minnesota.

Sec. 4. Shipments to be Accompanied by Certificates of Inspection.—All shipments from any point or points in the state of Minnesota to other points within the state must be accompanied by certificate of inspection on each package.

Sec. 5. Railroad and Express Companies Not to Transport Unless Tagged.—Railroad and express companies are hereby prohibited from accepting stock not tagged with certificate as above stated (and must promptly notify the shipper. If the shipper does not furnish a certificate, such companies shall report said fact with the name and address of party offering said stock for shipment to the State Inspector).

Sec. 6. Foreign Stock Must Be Inspected.—Foreign grown stock imported into Minnesota under the provision of the Federal Quarantine Law is regarded as coming under the definition of nursery stock and must be inspected at points of destination. It shall be unlawful for any party or parties to open any package containing such stock from a foreign country unless the inspector or deputy is present. It shall be the duty of the inspector to be present in person or by deputy when notified at least forty-eight hours in advance of the opening of such package.

Sec. 7. Dealers and Florists May Obtain Special Certificate.—Dealers or florists not owning nurseries and shipping by post, freight, express or otherwise may obtain from the State Entomologist a special certificate in order to comply with the Federal and State Laws. Such certificate will be granted only to stock purchased in Minnesota from an inspected nursery or to foreign stock inspected in Minnesota.

Sec. 8. Penalties.—Failure to comply with any of the provisions of this act shall be subject to the penalties provided in Section 2389, Chapter 38, Revised Laws of Minnesota, 1905.

Sec. 9. Annual Report Required.—The State Inspector shall be required on or before December 1st of each year to submit a report and financial statement to the Governor of the State, covering the year's work.

Sec. 10. \$3,000.00 Appropriated for Expenses.—For all expenses necessary to carry out the provisions of this act there is hereby appropriated from the State Treasury from money not otherwise appropriated the sum of \$3,000.00 annually. All fees collected hereunder shall be paid into the Treasury of the State of Minnesota and added to the State Entomologist's appropriation for combating injurious insects.

Sec. 11. Certain Sections Repealed.—Sections 2383 and 2384 of Chapter 38, Revised Laws of Minnesota, 1905, are hereby repealed.

Sec. 12. Existing Emergency Declared.—In view of an existing emergency this act is to become a law immediately after its passage and signature by the Governor.

Approved April 8, 1913.

A number of problems have presented themselves to the Entomologist and his deputies in connection with some of the sections of this law. Section 7 refers to the treatment accorded a dealer and, for some time, it was a question as to what constitutes a dealer. The general purpose of the inspection law is to prevent the introduction of dangerous insects or injurious diseases from other states and to also prevent the spreading of same in Minnesota. While dealers in the State are, for the most part, honest and careful as to where they buy their stock, there are some who unquestionably would not hesitate to fill their orders with stock from any source, grown perhaps in the far South, not hardy, possibly diseased, and in consequence many times purchased at a discount. In order to prevent this the above wording of this section was chosen, although it at times works a hardship upon the honest dealer. For example, dealers located near our state line, absolutely upright, are prevented by the terms of this provision, from purchasing stock in adjoining states, while the regular nurserymen who own their own property and propagate their own stock, can buy elsewhere. In meeting with this problem, as to what constitutes a dealer, we discussed this matter with many of our representative nurserymen who generally purchase from 8 to 15% of the stock sold. These men were originally, for the most part, dealers when they began this work, and neither they nor the inspectors are disposed to place any unnecessary restraint or unjust burden upon the men who are now beginning as dealers. Acting largely upon the advice of our representative nurserymen, it has seemed desirable to issue a dealer's certificate to a man who raises less than 50% of the stock sold. Before receiving a certificate, a dealer is obliged to file with the State Entomologist, an affidavit executed before a Notary Public, to the effect that all stock sold would be purchased in Minnesota from a duly inspected nursery, or would be represented by foreign (European or English) stock inspected in Minnesota. In 1913 eight of these certificates were issued to dealers. When we bear in mind that some of these dealers rent only a small plot of ground, or possibly a lot or two in the city, and heel in left-over stock, or perhaps grow a little stock and advertise it as a nursery, this decision of the Inspection Department seems a wise one. The section of the law so construed will be a check upon the spread of dangerous insects and injurious plant diseases in Minnesota, and be an inducement to all dealers to become regular nurserymen as soon as possible.

A criticism upon the law is made by some because a party not in the nursery business cannot ship a bundle of shrubs or trees from any point in the State to another without Certificate of Inspection signed by the State Entomologist attached to the package. This criticism is met with in the case of a citizen, not a nurseryman, desiring to ship stock, by the Entomologist giving a permit upon proper investigation, which permit is accepted by the expressman or at the freight office; or when desirable, stock can be sent to the Experiment Station and inspected there by the Entomologist and then forwarded to the consignee. In such case the shipper or the consignee must bear the expense of carriage coincident with this examination. This feature of the law, and the provision made for it by this office, must appear just to any one who bears in mind that this material, coming from a garden not inspected, might, for all we know, or the owner knows, to the contrary, harbor scale or other injurious insects or plant disease, and if permitted to be taken without inspection to another part of the state, might readily be the cause of spreading a pest or pests within our State border. In a few instances we have permitted private parties shipping a package not intended for trade purposes, to use the certificate of a nurseryman friend. This privilege has been abused, however, and hereafter each and every shipment of this kind must be accompanied by an official permit. In this connection we again remind our citizens that the Federal law is so constituted that no one in Minnesota can ship by parcel post without every and all shipments bearing Certificates of Inspection issued by the State Entomologist. State officials are of course powerless to change the Federal statute.

We find that quite a number of private parties who own gardens make it a point to sell plants, etc. Naturally, these should be inspected and receive a certificate, if entitled to same, for they come under the definition of "nursery," namely "a place where plants, trees, vines, shrubs, etc., are grown for sale."

TWO ENEMIES OF THE NURSERYMAN:

San Jose Scale and Crown Gall.

The presence of oyster shell scale on the apple in increasing abundance in Minnesota is of course a menace to the growing of good trees, and the woolly aphid of the apple, apparently on the increase here, would prevent a nurseryman from obtaining a certificate if present upon his trees in sufficiently large numbers.

There are, however, two pests in particular which we have with us: one, an insect not frequently observed here, though presumably more abundant in old orchards than the public is generally aware of, and the other a plant disease of bacterial origin, with us always, and causing the death of thousands of raspberry canes in Minnesota, whatever effect it may or may not have upon the apple.

San Jose Scale:

A fruit tree may be badly infested with oyster shell scale and still survive, but for some physiological reason, let one-half or one-fourth as many San Jose scales infest it and it generally succumbs. This much-dreaded insect has been found by the Inspection force three times in Minnesota nurseries, twice upon stock in two different nurseries, shortly after it had been brought here from another state (Pennsylvania), and recently, in our 1914 inspection, upon mountain ash received from Michigan a few years ago. The female scales upon these latter trees had matured and given birth to young which had infested an adjoining block of young apples. See Figure 1 on colored plate, representing a cutting from one of the apple trees referred to, showing characteristic reddening of the new bark where this scale is attached. Young scales were found crawling about amongst the parent scales, upon the apple and ash trees, even as late as the latter part of August. It is evident that these mature scales must have lived in Minnesota at least two winters, and we have personally, as an experiment, a few years ago, kept San Jose scales alive here, out of doors, on plum and apple for two succeeding winters. It is apparent, therefore, that this scale will endure our climate long enough to do considerable damage.

Our radical treatment of the conditions met with in this infestation of 1914 is referred to elsewhere. By a coincidence, at almost the same time as this discovery in the nursery, the Entomologist purchased from a leading grocer in Minneapolis some Seckle pears which were found badly infested with this same scale. See Figure 2, colored plate. Inquiry developed the fact that these pears also came from Michigan. It has been known, of course, for a long time that this scale existed in Michigan as well as in many other states, and there is nothing particularly threatening to the fruit industry of Minnesota in the fact of this infested fruit being sent here. At the same time, these two findings indicate either an indifference or lack of thoroughness and system, or lack of funds



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TWO ENEMIES OF THE NURSERYMAN

Figs. 1 and 2, San José Scale; Fig. 3. Crown Gall on Raspberry

in the Inspection work in the State referred to. In this connection it is interesting to know that, in 1913, officials in 27 states temporarily withheld certificates because this scale was present.

Crown Gall on Raspberries.

Hardly a nursery in Minnesota is absolutely free from this disease. See Figure 3, colored plate, and also Pl., facing p. 34. From 5% to 80% or over of raspberries were found affected in 1914. Perhaps Loudons are the most susceptible, although no variety appears to be absolutely immune. The disease is characterized by swellings on the root, as shown (and occasionally on the stem). It is also found upon the apple and plum; it is infectious and can be conveyed from cane to apple and vice versa. At one time the finding of a large percent of trees infested with crown gall would disqualify for certification, but with the lack of any proof of permanent injury upon the apple in doubt, as it is now, apparently many inspectors, Minnesota officials included, take but little note of affected apples. They are necessarily strict when the disease is found upon canes, for whatever the effect upon fruit trees, we know absolutely that it greatly weakens and kills raspberry plants, and have found hundreds of these plants in Minnesota dying from this disease. We have urged patrons of nurseries to scrutinize their raspberries, personally, when purchasing. Any consignment which shows even a small percentage of infestation should be rejected. Such exhaustive experiments have been made upon this organism, and so many instances of its infectious nature have been proven, that it seems unnecessary to discuss it. Rotation of crops and the prompt destruction of diseased plants is advised. One nurseryman claims that in planting cuttings he finds that he can, to a large extent, avoid infestation by planting deep at least 5 or 6 inches. This feature has not been made a matter of Station experimentation. It may be undertaken later. In the latitude of St. Paul, diseased plants of bearing age can easily be detected by their scant and drooping, frequently yellowing foliage. Such plants, if pulled, almost invariably show crown gall on roots. However, plants which look healthy above ground, may also occasionally bear gall below the surface. In 1913 inspection officials in 15 states withheld certificates temporarily on account of the presence of this disease in nurseries under their jurisdiction.

INSPECTION IN 1914.

The winter of 1913-14 was rather hard on nursery stock, but our inspectors state that on the whole the stock looks very well this season, some nurseries getting wonderful growth on certain trees.

Commenting on the copious rainfall last spring, Mr. Peake in his report states: "The month of June was so wet that clean culture was about impossible, the result of which was that a very bad crop of weeds and much hard work was required for the nurserymen to keep their fields clean. In one or two instances the weeds were so dense as to make thorough inspection almost impossible.

The Inspection Service feels that the nurserymen have done all in their power, with the possible exception of one or two cases, to help the Inspectors in their work, and especially when a pest was discovered, have been quick to co-operate for its eradication."

In connection with the occurrence of scales in some of the nurseries, several kinds of scale insects were found in the various localities and San Jose scale in one particular locality. At this latter place measures were at once taken to stamp out the scale while it was still under comparatively easy control.

The stock coming from this nursery will be as safe to buy as any, for there will be no possibility of live scales being sent from there. Not only has the place been carefully inspected and all infected stock taken care of, but all stock leaving the premises is treated so as to destroy any scales which might slip past the inspectors.

The following insect pests and plant diseases were reported by Mr. Peake upon nursery stock during 1914: Willow aphid, leaf roller on strawberry, snow ball aphid, leaf aphid, soft scales, leaf miners, leaf rollers on box elders, apple aphid, poplar beetles on poplar and willows, cherry slug, plum aphid, woolly aphid on apple, poplar scale, oyster shell on apple, scales on roses, Buffalontree hopper, snowy tree cricket, apple leaf hopper, lilac borer, tent caterpillar, canker worms and others. Also leaf spot on currant, mildew on same; shot hole fungus, especially on young plum; leaf spot on basswood, fire blight on mountain and apple ash; crown gall, black knot, fire blight canker on apple trees, black rust on barberry; plum pocket; anthracnose on blackberry, raspberry, etc.



Three varieties of Raspberries affected with Crown Gall. Washburn

INSPECTED MINNESOTA NURSERIES HOLDING CERTIFICATES OF INSPECTION.

Certificate Number	Name of Nursery	Proprietor or Manager	Town	Date of Expiration
659	The Albert Lea Nursery.....	C. M. Peterson.....	Albert Lea.....	Aug. 26
699	The Minnesota State Nursery.....	E. C. Eaker.....	Albert Lea.....	Aug. 27
660	The South Side Nursery.....	Martin Fridholm.....	Albert Lea.....	Aug. 26
680	The Wedge Nursery.....	Clarence and Robert Wedge.....	Albert Lea.....	Aug. 27
671	Alexandria Fruit and Poultry Farm.....	W. H. Horton.....	Alexandria.....	Sept. 13
648	The Askov Nursery.....	Ludvig Mosback.....	Askov.....	Sept. 8
662	The Austin Nursery Co.....	C. F. Woodde.....	Austin.....	Aug. 27
661	The Turtle Creek Nursery.....	J. M. Lindsay.....	Austin.....	Aug. 27
618	The Battle Lake Nursery.....	A. A. DeSmidt.....	Battle Lake.....	July 20
625	The Itasca Park Region Nursery.....	L. P. Anderson.....	Bemidji.....	July 6
681	The Byron Nursery.....	F. E. Cutting.....	Byron.....	Sept. 22
682	Oslund's Nursery.....	N. N. Oslund.....	Cambridge.....	Sept. 23
639	Sivert's Nursery.....	Peter Sivert.....	Canby.....	July 19
683	The Fillmore County Nursery.....	G. F. Snyder.....	Canton.....	Sept. 21
626	The Kokato Berry Farm.....	A. L. and F. Lee.....	Kokato.....	July 17
629	The North Star Farms.....	J. W. Beckman.....	Kokato.....	July 17
627	The Wright County Nursery.....	John Eklof.....	Kokato.....	July 17
611	The Vandermark Nursery.....	C. W. Vandermark.....	Crookston.....	May 10
616	The Deephaven Nursery.....	A. O. Hawkins.....	Deephaven.....	June 12
668	The Greysolon Nursery.....	C. E. Roe.....	Duluth.....	Sept. 9
596	The Taylor-Kenney Nursery.....	Taylor-Kenney Nursery Co.....	Eagle Bend.....	June 1
621	The East Grand Forks Nursery.....	Oscar Wick.....	East Grand Forks.....	July 7
622	The Lake View Nursery and Fruit Farm.....	P. M. Perry.....	Excelsior.....	June 15
678	Minnetonka Old Fashioned Flower Gdn.....	Mrs. M. S. Sawyer.....	Excelsior.....	June 15
679	The Amber Lake Nursery.....	P. C. Christensen.....	Fairmont.....	Aug. 30
684	McKisson's Fairmont Nursery.....	G. D. McKisson.....	Fairmont.....	Aug. 30
677	The St. John Nursery.....	B. E. St. John.....	Fairmont.....	Aug. 30
685	The Andrews Nursery.....	John P. Andrews.....	Faribault.....	Aug. 21
655	The Brand Nursery.....	The Brand Nursery Co.....	Faribault.....	Aug. 21
666	The Farmers' Seed and Nursery Co.....	Wm. Kueker.....	Faribault.....	Aug. 24
619	The H. Koppe Nursery.....	Hugo Koppe.....	Fergus Falls.....	June 29
672	The Wilverding Nursery.....	A. J. Wilverding.....	Freeport.....	Sept. 11
700	The Mills Lake Nursery.....	L. D. Mills.....	Garden City.....	Sept. 28
670	The Lake View Nursery.....	Victor Carlson.....	Grayling.....	Sept. 9
614	Hughart's Son's Nursery.....	Hughart & Sons.....	Hamel.....	June 15
628	The Howard Lake and Victor Nurseries.....	W. H. Eddy.....	Howard Lake.....	July 15
646	The Cook Nursery.....	Dewain Cook.....	Jeffers.....	July 22

INSPECTED MINNESOTA NURSERIES HOLDING CERTIFICATES OF INSPECTION.

Certificate Number	Name of Nursery	Proprietor or Manager	Town	Date of Expiration
665	The Kenyon Nursery.....	J. A. Mogren & Son.....	Kenyon	Aug. 31
664	The Oak Grove Nursery.....	P. H. Valstad.....	Kenyon	Aug. 31
686	The South Kenyon Nursery.....	E. J. Hershaug.....	Kenyon	Aug. 31
669	Ayers' Jack Pine Nursery.....	H. B. Ayers.....	Kimberly and Aitkin	Sept. 10
630	The Jewell Nursery.....	J. M. Underwood.....	Lake City	Aug. 20
633	The National Nursery.....	I. F. Anderson.....	Lake City	July 13
632	The Sugar Loaf Valley Nursery.....	Moseman Bros.....	Lake City	July 10
631	The Tolleason Nursery.....	G. A. Tolleason and A. V. Wickstrom.....	Lake City	July 8
642	Kenyon's Riverside Nurseries.....	J. M. Kenyon.....	Lamberton	July 21
643	The Motter Nursery.....	J. P. Motter.....	Lamberton	July 22
687	The Oak Valley Fruit Farms.....	H. W. Harrison.....	LeRoy	Sept. 20
688	The Benson Nursery.....	I. M. Benson.....	Lindstrom	Sept. 18
689	The Chicago Lake Nursery.....	Ludwig Carlson.....	Lindstrom	Sept. 18
602	The Morrison County Nursery.....	C. Kelly & Sons.....	Little Falls	July 18
615	The Minnetonka Nursery.....	Douglas Winter.....	Long Lake	July 14
613	The Tong Nursery.....	Geo. Tong.....	Long Lake	June 14
644	The Luverne Nursery.....	C. E. Older.....	Luverne	July 26
637	The Madison Nursery.....	M. Scholt.....	Madison	July 16
650	The Mankato Nursery.....	L. Z. Smith.....	Mankato	July 28
Dealers No. 16	.....	Neil Neilson.....	Mankato	July 20
Dealers No. 14	.....	M. M. Sinotte.....	Mankato	July 22
690	The Dodge County Nursery.....	W. E. Fryer.....	Mantorville	Sept. 22
636	The Orton Park Nursery.....	C. J. Orton.....	Marietta	July 15
658	The Deerfield Nursery.....	J. F. Brady.....	Medford	Aug. 25
657	The Medford Nursery.....	G. E. Patten.....	Medford 3	Aug. 25
605	The Baker Nursery.....	Harry Franklin Baker.....	Minneapolis	June 21
599	Board of Park Commissioners.....	Theo. Wirth.....	Minneapolis	June 24
701	Farmer's Nursery and Fruit Farm.....	E. A. Farmer.....	Minneapolis	Oct. 25
597	The Franklin Nursery.....	A. B. Franklin.....	Minneapolis	June 15
617	The Gould Perennial Garden.....	Mrs. E. W. Gould.....	Minneapolis	July 1
595	The Vine Grove Nursery.....	A. M. Shepard.....	Minneapolis	June 17
598	The Hunter Nursery.....	C. Hunter.....	Minneapolis	June 15
Dealers No. 17	.....	P. G. Johnson.....	Minneapolis and Lake City	July 12
Dealers 19	The Minneapolis Nursery.....	A. Norlander.....	Minneapolis	Oct. 9
Dealers No. 12	Minnesota Ginseng Growers Association.....	C. R. Klinkenberg.....	Minneapolis	June 1

Dealers No. 18 Northrup, King & Co.....	John Hawkins	Minneapolis	June 1
603 The Rose Hill Nursery.....	John Hawkins	Minneapolis	June 17
Tieglund's Nursery.....	J. L. Tieglund	Minneapolis	June 19
Dealers No. 11 Cumbercroft Farm and Nurseries.....	G. E. MacComber	Minneapolis	June 1
Dealers No. 15 The New Ulm Greenhouses.....	Chris. Booch	Nemadji	June 27
The Pioneer Nursery.....	Wm. Pfander, Jr.	New Ulm	July 27
649 The Northfield Seed and Nursery Co.....	J. M. Punderson	Northfield	Aug. 17
656 The Dunsmore Nursery.....	Henry Dunsmore	Olivia	July 13
634 The Clinton Falls Nursery.....	Thos. E. Cashman	Owatonna	Aug. 11
652 The Mitchell Nursery.....	D. M. Mitchell	Owatonna	Aug. 11
653 The Owatonna Nursery.....	L. J. Wesely	Owatonna	Aug. 11
673 The Elmwood Select Nursery.....	Frank Brown & Son	Paynesville	Sept. 15
620 The I. H. Bauer Nursery.....	J. H. Bauer	Perham	June 22
645 The Graham Nursery.....	O. J. Graham	Pine City	Sept. 8
676 The Preston Nursery.....	C. E. Snyder	Preston	Sept. 21
674 The Lake Sarah Specialty Farm.....	F. C. Rkel	Rockford	Sept. 16
694 The Vinegar Hill Nursery.....	Wm. Sandrock	Rushford	Sept. 21
635 The Sacred Heart Nursery.....	J. T. Flagstad	Sacred Heart	Sept. 14
Dealers No. 13 St. Cloud Nursery.....	E. L. Douglas	St. Cloud	July 8
693 The John Hill Nursery Co.....	John Hill	St. James	July 23
698 The Andersson Nursery.....	J. C. B. Andersson	St. Paul	Sept. 30
608 The Bailey Nursery.....	J. V. Bailey	St. Paul	June 11
607 The Hoyt Nursery.....	B. T. Hoyt	St. Paul	June 14
667 The Mayfield Nurseries.....	L. L. May	St. Paul and Lakeland	June 14
604 The Park Nursery.....	Holm & Olson	St. Paul	June 26
651 The Nicolle & Sibley County Nursery.....	C. Edwin Swenson	St. Peter	July 29
647 The Meininger Nursery.....	L. Meininger	Sherburn	July 24
601 The Ferodowill Nurseries.....	F. X. Ferodowill	Spring Park	June 19
695 The Strand Nursery.....	G. W. Strand	Taylor's Falls	Sept. 17
641 The Tyler Nursery.....	J. P. Erickson	Tyler	July 20
675 The Deephaven Nursery.....	Grace E. Kimball	Waltham	Sept. 20
616 The Hawkinson Nursery.....	A. O. Hawkins	Wayzata	June 12
623 The Redpath Nursery.....	Charles Hawkinson	Wayzata	June 15
612 The West Concord Nursery.....	Thos. Redpath	Wayzata	June 15
696 The Winnebago Nursery.....	F. J. Cowles	West Concord	Sept. 20
663 The S. D. Richardson Nursery.....	John Van Blair	Winnebago City	Aug. 28
697 The Pfeiffer Nursery.....	S. D. Richardson	Winnebago City	Aug. 28
610 The University Fruit Farm Nursery.....	C. A. Pfeiffer & Son	Winona	June 10
593 The University Fruit Farm Nursery.....	State of Minnesota	Zumbra Heights	April 13

INSPECTED MINNESOTA NURSERIES NOT HOLDING CERTIFICATES

1914.

Dealer	.....	Robert H. Black.....	Albert Lea
Dealer	The Flyen Nursery Co.....	Henry Flyen.....	Dawson
Dealer	.....	P. J. LeBorions.....	Duluth
Dealers	Duluth Floral Co.....	.....	Duluth
Dealer	.....	W. W. Seekins.....	Duluth
	The Elmore Nursery.....	Jens J. Coupanger.....	Elmore
	Birch Lake Ginseng Gardens.....	Vet Brees.....	Grey Eagle
	.....	Freeman Thorpe.....	Hubert
	.....	Loegren.....	Long Prairie
	.....	J. S. Harris.....	La Crescent
	.....	Woolenwider.....	La Crescent
	.....	Geo. B. Covey.....	Medford
	.....	Ruedlinger.....	Minneapolis
Dealer	The Plainview Nursery.....	R. W. Chapman.....	Plainview
	.....	J. S. Bixby.....	Richville
Dealers	The Minnesota Nor. Nurs'y.....	J. E. and E. C. Killmer.....	St. Paul
	.....	D. W. C. Ruff.....	St. Paul
	.....	Paul P. Klevann.....	Starbuck
	Norway Poplar Forest Grove.....	Emil Sahler.....	Waseca

During the past year, the Inspection Service has inspected 640 containers of foreign stock which has been shipped in from various countries of Europe, especially Belgium, Holland, France, Germany, and England. Of this stock, more than 21,000 plants were roses, over 18,000 azaleas; spirea, 20,000; apple seedlings, 36,000; palms, 1,440; syringas, 1,575; clematis, 651; tree roses, 200; lilacs, 907; rhododendrons, 152; aspidistra, 1,290; plum stock, 500; acer, 450; coniferous trees, 1,360; citrus, 37; astilbe, 400; aralia, 160; ulm, 225; quercus, 125; araucaria, 900; fruit stock, 200; box pyramids, 50; laurels, 50; philadelphus, 2,427; cornus, 2,710; caragana, 500; rhamnus, 4,140; calycanthus, 200; evergreen shrubs, 1,950; forest and deciduous trees, 11,265; deciduous shrubs, 131,398; field grown floral stock, 4,800; ribes, 5,295; picea, 600; betula, 6,450; pinus, 10,000; abies, 10,575; chamaccerasus, 4,000; symphoricarpos, 19,200; amelanchier, 1,700; berberis, 8,000; amygdalus, 2,000; corylus, 2,000; deutzia, 500; bay trees, 98; sambucus, 2,350; buckthorn, 10,000; hydrangeas, 1,540; viburnum, 11,000; boxwood, 100; buxus, 500; spruce, 136; sorbus, 8,315.

A summary of the moneys collected as fees for the Nursery Inspections as provided by Sections 1 and 7 of the Nursery Inspection Act is as follows:

Aug. 15, 1914.	State Treasurer's Receipt No. 1518	\$240.00
Nov. 19, 1914.	State Treasurer's Receipt No. 1808	320.00
	Cash on hand	10.00
		<hr/>
		\$570.00
Cash brought forward		5.00
3 Inspection fees due 1913, paid 1914		15.00
101 Nursery Inspection Fees		505.00
9 Special Inspection Fees		45.00
		<hr/>
		\$570.00

PROPOSED LEGISLATION AFFECTING STATE ENTOMOLOGIST AND NURSERY INSPECTION.

The State Efficiency Commission recommends that the State Entomologist's duties be transferred from the University to the proposed State Department of Agriculture, which the legislature may create at the next or some subsequent session, upon the ground that it is more fitting that police work, if nursery inspection work can be so regarded, be done by a State Department rather than by the University. It is further proposed that the University co-operate with such official to the extent of performing whatever research work is needed by the State Department, perhaps furnishing some assistance to the inspector when such is needed in the discharge of his duties.

We have every reason to believe that this is a good plan, particularly from the standpoint of the University, which institution should be freed of responsibility of any work representing the discharge of State laws, and we heartily endorse the views of the Commission. It is evident, however, that such an arrangement would be more expensive to the State than inspection is at present. Under the existing plan, where the entire salary of the Entomologist is paid through the University, and where we can have recourse to assistance of properly qualified Agricultural College or Station experts at times when the demands of the work require it, inspection costs the State approximately \$4,000 per annum. Under the arrangement suggested, wherein it would be necessary to engage permanent help of a high grade, it would call for at least \$12,000 or \$14,000 per annum for nursery and orchard inspection alone.

We very much doubt, however willing University authorities might be to co-operate, that when it came to the actual demand for assistance, without clearly defined legal authority for same established, that the request would or could be always granted.

The above figures are conservative and based upon careful study of the work in Minnesota, compared with the following states where the State Entomologist is not connected with University or Experiment Station. Letters of inquiry have brought out the following facts: In Pennsylvania the annual appropriation for Nursery Inspection work is \$40,000. They have two permanent research assistants at \$1,500 each, and about 25 permanent field assistants, each drawing a salary of \$125 per month. The Assistant Entomologist receives \$2,000 per annum. The yearly expenses of field and office work of the State Entomologist of Illinois

approximate \$25,000. (This includes \$2,500 for Chinch Bug work.) The State Entomologist's Department of Indiana has on an average 5 permanent field assistants and 3 temporary field assistants, each at a salary of \$100 per month, and one office assistant at the same figure. Their annual appropriation for inspection (including bee inspection) is \$15,000. Georgia appropriates \$38,000 per year for their Entomologist. In that state they have 5 permanent research assistants, one drawing a salary of \$2,000, and 4 receiving \$1,800 each. They also have 3 office assistants. Ohio spends about \$12,000 annually upon this work, having 9 permanent field assistants, one at \$1,500, one at \$1,400, 4 at \$1,200 and 3 at \$1,080 per year.

Two matters which would affect Nursery Inspection in all states are being carefully considered by the American Association of Horticultural Inspectors. One is to bring about a standard of phraseology and value of inspection certificates, doing away with the prevailing diversity of wording and meaning, which is frequently both confusing and misleading. The report of the committee appointed to consider this matter will be discussed at the coming meeting of the Association at Philadelphia in December.

The second point under consideration is the adoption by all states of a similar inspection law. This movement also, as well as the first mentioned, is intended to do away with diversity of laws and make all inspection work more uniform. The tentative bill has been practically approved by the American Association of Horticultural Inspectors and endorsed in its main features by the American Association of Nurserymen. It would be impossible to include here the entire wording of the act, and we consequently merely abstract certain provisions the nature of which might provoke discussion on the part of nurserymen. Our personal opinion upon the points cited is expressed in each case.

Section 1. Par. 1. "The term 'nursery' would include any grounds or premises on which nursery stock is being fumigated, packed or stored."

Comment: Since nursery stock is sometimes stored in department stores which sell the same, it is possible that, by free interpretation, department stores might be included.

Par. 2. Defining nurserymen.

Par. 3. Defining nursery stock.

Par. 4. "The term 'dealer' shall be construed to apply to any person, firm or corporation, not growers of nursery stock, who buy nursery stock for the purpose of reselling and reshipping under their own name or title, independently of any control of a nursery."

Comment: We regard this section as too lax, for a dealer might easily be growing a little nursery stock and still be purely a buyer and seller of nursery stock. Our own ruling in Minnesota seems much better; namely,

that if a man can show that he raises 50 per cent or more of the stock he sells, we regard him as a nurseryman and entitled to a regular certificate.

Sec. 2. Provides for the creation of a state horticultural inspection board, forming a court of appeal from an inspector's decision.

Comment: Since there would be some delay in getting members of this board together to relieve the distress of some nurseryman who might think he had been wronged, some provision should be made for more prompt settlement than a meeting of the full board.

Sec. 10. "It shall be unlawful for any person, firm or corporation in this state knowingly to permit any dangerous insect or plant diseases, hereby declared to be a public nuisance, to exist on their premises. It shall also be unlawful to offer for sale any infested or infected stock."

Comment: We regard this as a most excellent provision.

Sec. 13. "Nurserymen, dealers, or any person, firm or corporation desiring to sell or ship nursery stock shall make application before July 1st of each year to the State Nursery Inspector for inspection of their stock and any one failing to comply with this section shall be liable for extra charges to cover traveling expenses of the inspector."

Comment: This also we regard as being a most excellent provision.

Sec. 14. Par. 1 has to do with the issuing of a certificate, which certificate sets forth the fact of the inspection and also the number of acres or fractions thereof inspected.

Comment: Some Minnesota nurserymen might possibly object to their acreage being made public.

Sec. 15 provides that all dealers shall secure a dealers' certificate by furnishing a sworn affidavit that they will buy and sell only stock which has been duly inspected and certified to by an official inspector and that he will maintain with the inspector a list of all sources from which he secures his stock.

Comment: We have not this latter provision in Minnesota, but it seems to be a most excellent thing.

Sec. 18 states that it shall be unlawful to willfully misrepresent the character and variety of stock offered for sale or to make a false declaration of acreage or to cause any concealment of stock from inspection.

In the same section, any person, firm or corporation selling nursery stock in the state shall, if requested, furnish the inspector with copies of their order forms, contracts and agreements which are furnished for the use of agents or customers or both.

Sec. 20. "The use of tags or posters bearing an invalid or altered certificate and the misuse of any invalid certificate is prohibited."

Minnesota nurserymen are probably aware of the fact that Canadian authorities have opened a new fumigation station at North Portal, Sask., and that the Canadian importation season was not extended from October 7th to October 1st, as at first planned. The Entomologist decided that it would not be desirable to fumigate nursery stock as early as October 1st, accordingly no change has been made in the Canadian regulations.

Field Mice in Nursery and Orchard.

Field mice have caused Minnesota horticulturists enormous losses by the girdling of orchard, nursery and young shade trees. In one season (1902) nursery stock in the vicinity of Rochester, New York, suffered a loss of \$100,000 due to the work of field mice. We have no hesitancy in saying that the war of extermi-

nation carried on against Hawks, Owls, Crows, Skunks, Foxes, Badgers and Weasels, all of which at times prey upon field mice, is to a large extent responsible for present day losses in this particular.

The extreme fecundity of this pest is emphasized by a published statement of D. E. Lantz, that "a single pair and their progeny in five seasons, would amount to nearly 1,000,000 individuals."

While the clearing up of all rubbish piles which afford places of refuge for these pests, is desirable and helpful, the nurseryman will have to resort to some offensive measures if his trees in orchard and nursery are in a locality likely to be overrun with mice. In the light of our present knowledge, we believe that poisoned grain is the best means of control. One progressive nurseryman claims to have obtained relief in his orchard by placing poisoned wheat in old cans at every other tree. In view of the fact that quail and other grain-eating birds could easily obtain the poisoned material from the open cans, it was suggested that the same bait be placed under boards raised an inch or two from the ground, would be just as attractive, or more attractive, to mice and at the same time prevent birds having access to it.

The Entomologist is testing certain advertised materials claimed to inoculate mice and spread disease amongst them, but sufficient data are not yet available upon which to publish results.

A small area infested with field mice, or houses invaded by them, may be practically freed by the use of the small wooden mouse traps, which sell at the rate of two or three for 5 cents. Smear the pan with bacon and then dust oatmeal over it.

NURSERY INSPECTION FUND.

Cash Account.

AUGUST 1, 1913, TO DECEMBER 1, 1913.*

Cash on hand (Appropriation)		\$3,000.00
Assistant Inspector's Salary.....	\$ 625.00	
Clerk and Accountant	150.00	
Expert Assistants, Traveling Expenses, etc.....	595.62	
Postage	20.00	
Printing	50.25	
Telephone	15.00	
Traveling Expenses of Assistant Inspector.....	305.57	1,761.57
Balance.....		\$1,238.56

* NOTE—The above covers only four months work.

Cash Account.

DECEMBER 1, 1913, to DECEMBER 1, 1914.*

Cash on hand	\$1,238.56	
Appropriation (Aug. 1, 1914, to Aug. 1, 1915).....	3,000.00	\$4,238.56
Assistant Inspector's Salary.....	\$1,291.65	
Drawings for Inspector's Report.....	6.00	
Expert Assistants, Traveling Expenses, etc.....	475.90	
Express	1.61	
Office Supplies	4.70	
Printing	4.00	
Subscription to National Nurseryman.....	2.00	
Telephone	5.00	
Traveling and Miscellaneous Expenses of Inspector....	36.34	
Traveling Expenses of Assistant Inspector.....	561.25	2,388.45
Balance.....		\$1,850.11

* NOTE—Stenographer and clerk paid from State Entomologist Fund; also bills for June, 1914 (\$242.15). Eight months expenses, December 1, 1914, to end of fiscal year August 1, 1915, must be met with the balance available.

ABSTRACTS OF INSPECTION LAWS IN VARIOUS STATES.

We include here abstract of inspection laws of all states where inspection is in force, for the benefit of our nurserymen, and suggest that shippers become familiar with the laws of those states into which they propose to ship, thus avoiding delays and possible loss. This list is the latest which has come to our attention, being compiled by officials in New Jersey, and is dated March, 1914. It is therefore probably correct in all essential features.

Alabama. Every nurseryman or dealer in nursery stock doing business in Alabama must take out a license, which is of two kinds: one regular nurseryman and dealer's license and another an agent's license, the agent's license to be obtained only through the principal, who must hold a regular nurseryman's or dealer's license. The fee for each nurseryman's or dealer's license is ten dollars (\$10.00). The fee for each agent's license is one dollar (\$1.00). All license fees must be paid before the license is granted. A signed copy of the inspection certificate held by the applicant must be filed with the State Horticulturist and money sent to pay for the license and tags needed. A tag must be placed on each order delivered. One tag on a box does not cover individual orders therein. No one is allowed to receive a package of nursery stock unless a tag is attached. Printed official tags are furnished at a cost as follows: First one hundred, 65 cents postpaid; first two hundred, \$1.00 postpaid; first three hundred, \$1.20 postpaid; first five hundred, \$1.60 postpaid; in thousand lots, \$2.20, sent by express collect. Personal checks will be received. Use money order or draft. Send small amounts in two-cent stamps. It is unlawful for any person, firm or corporation outside of the State of Alabama to ship into the State any citrus stock for propagation or for planting unless said stock is first completely defoliated and fumigated with hydrocyanic acid gas of standard strength. Further, the official inspection tag on such shipment or shipments must state that such citrus stock has been properly defoliated and fumigated. E. P. Sandsten, State Horticulturist, Auburn, Alabama.

Arizona. Nursery stock shipped into the State must be prominently labeled with the name and the address of both the shipper and the consignee, and must be accompanied by a valid certificate of inspection or a copy of

such certificate. Shipments into the State, consisting of or containing plants not grown in the locality from which shipment was made, must in addition, specify where such plants were grown. State quarantine orders of interest to nurserymen prohibit: (1) the importation of stock from sections infested by the alfalfa weevil; (2) the importation of citrus, privets, cape jessamine and rubber trees and plants from North and South Carolina and all States bordering on the Gulf of Mexico; (3) rooted grape vines from north of the line of San Bernardino, Kern and San Luis Obispo counties, California; (4) citrus trees from California except from Imperial, Tulare and Fresno counties. All shipments of living plants into the State of Arizona are inspected by Arizona State Inspectors and not delivered until a certificate of release is issued in each case, to the common carrier and to the consignee. If trees or plants are infested or infected with insect pests or plant diseases of general occurrence in the section of the State where the shipment is received, treatment to eradicate, or the separation of the infested or diseased plants or trees, is in most cases permissible; otherwise all plants or trees of the kind found to be infested or diseased are held in quarantine and are shipped from the State or destroyed at the owner's option. Copies of quarantine orders furnished upon application. A. W. Morrill, State Entomologist, Phoenix, Arizona.

Arkansas. Shipments of nursery stock into the State must be accompanied by a copy of the valid certificate of inspection, a copy of the valid permit issued to the nurseryman by the State Entomologist of this State and must bear the name and address of the consignor and consignee with a brief statement of the contents of the shipment; all shipments not so labelled or tagged must be refused for shipment by the carrier. Carriers bringing into the State shipments of nursery stock which originated in foreign countries or foreign possessions of the United States must notify the State Entomologist in writing and must hold such stock at any place designated by him until the same has been duly inspected and released. Nurserymen located out of the State may secure permits by filing with the State Entomologist a copy of their certificate. George G. Becker, State Entomologist, Fayetteville, Arkansas.

California. All horticultural material of every kind is inspected upon arrival. Shipments are held by transportation companies until inspected by State or county inspectors. Each carload, case, box, package, crate, bale or bundle of trees, shrubs, plants, vines, cuttings, grafts, scions, buds, fruit-pits or fruit or vegetables or seed, imported, or brought into this State, shall have plainly and legibly marked thereon in a conspicuous manner and place, the name and address of the shipper, owner or owners, or person forwarding or shipping the same, and also the name of the person, firm or corporation to whom the same is forwarded or shipped, or his or its responsible agents; also the name of the country, State or territory where the contents were grown and a statement of the contents therein. Peach, nectarine or apricot trees, or any trees on peach roots from districts infested with peach yellows or peach rosette, will be refused entry. Notices of all shipments should be sent to the horticultural quarantine officer, Room 11, Ferry Building, San Francisco, California. Frederick Maskew, Chief Deputy Quarantine Office, Room 11, Ferry Building, San Francisco, California.

Colorado. All shipments into the State must bear certificates of inspection and fumigation. All shipments are inspected by county inspectors. Trees with crown gall or hairy root will be condemned and destroyed unless promptly removed from the State. G. P. Gillette, State Entomologist, Fort Collins, Colorado.

Connecticut. All imported stock must not be unpacked without permission from the State Entomologist's office, and all stock entering the State must bear a certificate of inspection. Dr. W. E. Britton, State Entomologist, New Haven, Connecticut.

Delaware. Shipments into the State must bear a certificate of inspection and a statement from the shipper that the stock has been fumigated. Wesley Webb, Inspector of Orchards and Nurseries, Dover, Delaware.

Florida. All shipments of nursery stock into the State without certificates of inspection and fumigation are illegal. All shipments of citrus trees, chinaberry, umbrella trees, cape jessamine, privets, persimmons, green ash, cherry, laurel, virburnum, nudum, pomegranate, allamanda and other plants subject to white fly infestation must have their leaves removed. All outside persons selling nursery stock within the State must pay a fee of five dollars (\$5.00), register with the inspector of nursery stock and file a certificate of inspection before receiving permission to sell. All shipments must be securely boxed, or covered to prevent infestation or infection. Dr. E. W. Berger, Inspector of Nursery Stock, Gainesville, Florida.

Georgia. Nurserymen or dealers in nursery stock residing in other States, who desire to ship nursery stock into Georgia, must file with the State Entomologist (Atlanta, Ga.), a copy of their certificate of nursery inspection signed in person by a duly authorized State or Government Entomologist. In addition to the certificate the nurserymen are required to file a signed agreement to the effect that all stock consigned to points in Georgia will be fumigated with hydrocyanic acid gas, in a manner approved by the State Entomologist of Georgia. Upon receipt of the above-mentioned certificate and fumigation agreement the official tag of the Georgia State Board of Entomology is issued to the nurseryman at the cost of printing, as follows: 100 tags, 60 cents postpaid; 200 tags, 85 cents postpaid; 300 tags, \$1.10 postpaid; 500 tags, \$1.35 sent by express collect; 1,000 tags, \$2.00, sent by express collect. All shipments of nursery stock into Georgia must bear a copy of the official Georgia tag, which bears a facsimile of the signature of the Entomologist of Georgia, and also a copy of the certificate issued by the proper official of the State where such shipment originated. Any shipment not so labeled shall be liable to confiscation upon the order of the Entomologist of Georgia. E. L. Worsham, State Entomologist, Atlanta, Georgia.

Idaho. All nursery stock shipped into the State is inspected upon its arrival, the consignee paying for such inspection. Shipments must bear a label showing the name of the shipper, the locality where grown and variety of nursery stock, in addition to a copy of an official certificate of fumigation emanating from the place where the stock was grown. Application to sell stock in the State must be made to the State Board of Horticultural Inspection, a bond of \$5,000 filed and annual license secured upon payment of \$10.00. Every nursery firm doing business in the State must pay one dollar (\$1.00) annually for each agent who represents them. All nursery stock sold or delivered must be true to name and variety as represented. J. U. McPherson, State Horticultural Inspector, Boise, Idaho.

Illinois. Each shipment coming into the State must bear a certificate of nursery inspection. Agents and dealers selling stock obtained from outside nurserymen must file every year with the State Entomologist a sworn statement with certificates showing sources of stock. Dr. S. A. Forbes, State Entomologist; P. A. Glenn, Chief Inspector, Urbana, Illinois.

Indiana. Stock shipped into the State from another State or from one point to another within the State, must be plainly labelled with the name of the consignor and consignee and must bear a certificate of the State or government official showing that the enclosed stock has been inspected and found free from injurious insects and plant diseases. All foreign-grown nursery stock is unpacked and inspected by the State Entomologist upon arrival at its destination in Indiana. C. H. Baldwin, State Entomologist, Indianapolis, Indiana.

Iowa. Duplicate certificates of nursery inspection must be filed with and approved by the State Entomologist. Stock shipped into the State must bear an official certificate of inspection. Prof. H. E. Summers, State Entomologist, Ames, Iowa.

Kansas. A certificate of inspection must accompany every shipment of stock into the State. Prof. George A. Dean, Manhattan, Kansas, and Prof. S. F. Hunter, Lawrence, Kansas.

Kentucky. All packages of stock shipped or delivered in the State must bear a copy of a valid certificate from an official inspector. In addition, each package must bear on the outside a statement of its contents and be plainly labelled with the names of the consignor and consignee. Copies of certificates may be filed with the State Entomologist. Prof. H. Garman, State Entomologist, Lexington, Kentucky.

Louisiana. All stock must be labelled with certificate of inspection, and in addition a copy of such certificate must be filed with the State Board of Agriculture and Immigration. All shipments of orange, lemon, lime, sweet lime, kumquat, Tangerine, grape, fruit trees or other citrus plants shipped into this State must be completely defoliated. All correspondence should be addressed to J. B. Garrett, Entomologist, State Board of Agriculture and Immigration, Baton Rouge, Louisiana.

Maine. All stock coming into the State must bear a certificate of inspection. J. A. Roberts, Commissioner of Agriculture, Augusta, Maine; A. R. Lardner, State Entomologist, Augusta, Maine.

Maryland. Stock shipped into the State must contain a certificate of nursery inspection and the names of the consignor and consignee. All trees are required to be fumigated with hydrocyanic acid gas. A duplicate certificate of inspection must be filed with the State Entomologist. Prof. T. B. Symons, State Entomologist, College Park, Maryland.

Massachusetts. There are no requirements whatever with reference to sending stock into Massachusetts, not even a certificate being needed. All stock, however, received in this State is inspected at its destination, and if its condition requires action of any kind, such as its destruction, return to the consignor, or anything of the sort, this is taken as the result of our inspection, and any shipper sending bad stock into the State does so at his own risk. Dr. H. T. Fernald, Chief Nursery Inspector, Amherst, Mass.

Michigan. Shipments of stock into the State must have attached certificate of inspection. Trees and shrubs subject to the attack of San Jose scale must be fumigated with hydrocyanic acid gas and a statement to this effect, from the nurseryman, should accompany each shipment. Nurseries having agents canvassing for the sale of stock in Michigan are required to take out a license for which the fee is five dollars (\$5.00), and in addition file a bond for one thousand dollars (\$1,000). Certificates of inspection must be filed with the State Inspector of Nurseries before any stock is shipped into the State. A license is not required for stock sold on mail orders, but a copy of the certificate should be filed and another copy attached to each package shipped into the State. Prof. L. R. Taft, State Inspector of Nurseries, East Lansing, Michigan.

Minnesota. Nursery stock brought into the State must bear an official certificate of inspection. In addition a duplicate certificate of inspection must be filed with the State Entomologist, before shipments of stock are made. Railroad and express companies are prohibited from accepting stock not properly certified. Prof. F. L. Washburn, State Entomologist, St. Anthony Park, Minnesota.

Mississippi. All stock shipped into the State must bear a certificate of nursery inspection and fumigation statement and a copy of such certificate must be filed with the Entomologist in addition to a statement that all stock shipped into Mississippi will be fumigated with hydrocyanic acid gas. R. W. Harned, Entomologist, Agricultural College, Mississippi.

Missouri. Nurserymen shipping stock into this State must apply to the State Inspector for a permit, accompanying the application with a copy of their nursery inspection certificate and an affidavit that no stock will be shipped into Missouri which has not been duly inspected and certified. No fee is charged. Agents for outside nurseries must apply for an agent's permit. All shipments entering the State must bear a statement of its contents, name of consignor and of consignee and a certificate of inspection. Prof. Leonard Haseman, Entomologist and Chief Inspector, Columbia, Missouri.

Montana. All stock shipped into the State must be unpacked and inspected and if necessary fumigated. This takes place at the following quarantine stations: Miles City, Billings, Dillon, Missoula, Glendive, Livingston, Baker, Big Timber, Bozeman, Kalispell, Great Falls, Troy, Plains, Glasgow, Eureka, Helena, Mondak, Havre and Anaconda, or at other points of delivery upon payment of all costs. All persons shipping stock into the State must secure a license for which the fee is ten dollars (\$10.00), and file a bond for one thousand dollars (\$1,000) with the State Horticulturist. License is good for one year from date of issue. Notice of shipment including an invoice of stock must be sent to the State Horticulturist five days before day of shipment. M. L. Dean, State Horticulturist, Missoula, Montana.

Nebraska. Shipments of nursery stock entering this State must bear a certificate of nursery inspection and be labelled with the name of the consignor and consignee. Prof. Lawrence Bruner, State Entomologist, Lincoln, Nebraska.

Nevada. All nursery stock shipped from other States to points within the State of Nevada, whether fruit trees, ornamental trees, shrubs, vines, cuttings, or other nursery stock of any description whatever must bear on the outside of each car, crate, bale, bundle or package a label giving the name of the consignor and consignee, together with a copy of an inspection certificate of recent date. Such certificate of inspection must certify that said stock has been inspected and found free from insect pests or plant disease of any kind. It must bear the signature of the State Entomologist or Plant Pathologist or other duly qualified person in authority in the State in which said nursery stock was grown. J. E. Stubbs, President, State University, Reno, Nevada.

New Hampshire. Each shipment into the State must contain a certificate of nursery inspection or an affidavit showing that the stock has been properly fumigated with hydrocyanic acid gas. W. C. O'Kane, Acting State Nursery Inspector, Durham, New Hampshire.

New Jersey. The law requires the inspection of all nurseries at least once in each year. Shipments into the State must be accompanied by a certificate of inspection of current date, or copy thereof, attached to each car or parcel, together with a statement from the shipper that the stock therein is a part of the stock inspected, and stating whether such stock has been fumigated with hydrocyanic gas or not. It shall be the duty of all carriers to refuse for transportation within the State, all stock not accompanied by a certificate of inspection. All stock coming into the State may be detained for examination, wherever found, by the State Entomologist or the State Plant Pathologist, and if found to be infested with any insects or plant diseases, injurious or liable to become so, will be destroyed. Dr. T. J. Headlee, State Entomologist, New Brunswick, New Jersey; Dr. Mel. T. Cook, State Plant Pathologist, New Brunswick, New Jersey.

New Mexico. No laws covering transportation of nursery stock. The Territorial Legislature of 1903 provided for county boards of horticultural commissioners, which were given authority to control orchard pests. Prof. Fabian Garcia, Horticulturist, Agriculturist Experiment Station, State College, New Mexico.

New York. Any nursery stock brought into the State must remain unpacked and unopened until permission is given by the Commissioner of Agriculture. All stock is inspected at destination. To facilitate rapid inspection receivers of nursery stock should notify the Department Office at Albany of the receipt of consignments. It would also be well for shippers into the State to notify the Commissioner of Agriculture, giving all names and possible date of arrival. All nursery stock shipped into this State must bear a copy of a certificate of inspection. Calvin J. Huson, Commissioner of Agriculture, Albany, New York.

North Carolina. Stock shipped into the State must bear a certificate of nursery inspection and also a statement that the stock has been fumigated. A duplicate certificate must be filed with the State Entomologist. Franklin Sherman, Jr., Entomologist, State Department of Agriculture, Raleigh, North Carolina.

North Dakota. Nursery stock shipped into the State must bear a certificate of inspection. Every individual, firm or corporation who employs agents or traveling salesmen, or who solicits for the sale of nursery stock in the State, must obtain a license from the Director of the North Dakota Experiment Station, the cost of which is ten dollars (\$10.00). In addition a certificate of inspection and a bond for five hundred dollars (\$500) must be filed. License is good for one year following date of issue. Director North Dakota Experiment Station, Agricultural College, North Dakota.

Ohio. Shipments of nursery stock entering the State must bear the name of the consignor and consignee, and be accompanied by an official certificate of inspection or fumigation. Agents are required to pay a license fee of one dollar (\$1.00) and dealers a license fee of five dollars (\$5.00); also to file sworn statements that the stock which they sell or deliver has been officially inspected and was received by them accompanied with a valid certificate of inspection or fumigation. N. E. Shaw, Chief Inspector, Ohio Department of Agriculture, Columbus, Ohio.

Oklahoma. Outside nurserymen desiring to do business in Oklahoma must file in the office of the State Entomologist, prior to shipping, a duplicate copy of the season's inspection certificate, and give such information in regard to their business methods as may be necessary to convince the Oklahoma Entomological Commission that they are conducting their business in a fair and honorable way. Each individual shipment must be accompanied by a tag bearing valid copy of said inspection certificate. Failure to comply with this rule will render shipment subject to confiscation. Benjamin F. Hennessy, Secretary, State Board of Agriculture, Oklahoma City, Oklahoma.

Oregon. All nursery stock shipped into the State is inspected at point of delivery. All nursery stock, shipped into the State, which is affected with crown gall or hairy root will be destroyed or returned. It is unlawful for any person to send or bring into Oregon, peach trees, nectarine trees, apricot trees or trees on peach roots or peach pits from districts where the peach yellows or peach rosette is known to exist. Shippers of nursery stock must mark on each package, in a legible manner, the name and address of shipper, name and address of consignee, the place where the contents were grown, and the fact that the contents are nursery stock, seedlings, or seeds as the case may be. H. H. Williamson, Secretary, State Board of Agriculture, Portland, Oregon.

Pennsylvania. Certificates of fumigation are required to accompany shipments from other States and the word "fumigated" printed or stencilled on or accompanying the certificate of inspection will not be accepted unless it is apparent that such word is a part of the certificate granted by a State Inspection officer. Nurserymen from other States are also required to file affidavits that all nursery stock of kinds subject to infestation by San Jose scale will be properly fumigated before shipment into the State. Blanks furnished upon application. Transportation companies are required to reject all stock entering the State unless certificates of inspection and fumigation are attached. Prof. H. A. Surface, Economic Zoologist; Enos B. Engle, Chief Nursery Inspector, Harrisburg, Pennsylvania.

Rhode Island. All shipments of nursery stock into the State must have attached to each package in a conspicuous place, a copy of the certificate of inspection signed by an official inspection officer. Agents having no nursery, who wish to sell stock within the State must apply to the State Entomologist for an agent's license and must state where they propose to purchase the stock they intend to sell. A. E. Stene, Entomologist, Kingston, Rhode Island.

South Carolina. Stock coming from other States, provinces, or foreign countries and consigned to points within this State, must have attached to every bundle or package an interstate tag or permit issued by the South Carolina State Crop Pest Commission. This interstate tag or permit can be issued only after the certificate of inspection of the State, country or province where shipments originated, has been approved by the South Carolina State Crop Pest Commission and filed in the office of the entomologist or pathologist of the State Crop Pest Commission. It is further required that the fumigation certificate of the South Carolina State Crop Pest Commission be properly filled out and filed in the office of the entomologist or pathologist of the Commission before the interstate tag or permit can be issued, unless the official inspection certificate includes a statement that the nursery is properly equipped for fumigating. Prof. A. F. Conradi, State Entomologist; Prof. H. W. Barre, State Pathologist, Clemson college, South Carolina.

South Dakota. Nurserymen residing outside of South Dakota must file in the office of the State Entomologist a copy of his official inspection certificate and in addition attach to each shipment of stock coming into South Dakota, a copy of his inspection certificate and a statement stating where the stock was grown. Prof. Harry C. Severin, State Entomologist, Brookings, South Dakota.

Tennessee. All shipments of stock into the State must have attached a certificate of inspection and a fumigation tag. Outside nurserymen must file in the office of the State Entomologist, Knoxville, Tennessee, a duplicate certificate of their nursery inspection signed in person by the official in charge, and in addition file in that office an agreement signed by the proprietor of the nursery to thoroughly fumigate with hydrocyanic acid gas all nursery stock subject to San Jose scale and other dangerous insect pests. Prof. G. M. Bentley, State Entomologist and Plant Pathologist, Knoxville, Tennessee.

Texas. Before shipping nursery stock into this State nurserymen must file with the Commissioner of Agriculture a certified copy of their inspection certificate. In addition a fee of five dollars (\$5.00) is charged for the issuance of a permit to ship into the State. All shipments must bear a certificate of inspection from the State in which the shipment originated and a tag showing copy of the permit from Texas. Agents are required to procure agents' credentials from their nurseries on a form approved by the Commissioner of Agriculture. Dealers are required to take out the same permit as nurserymen. Greenhouse plants are included in the inspection. Commissioner of Agriculture, Austin, Texas.

Utah. No person can engage in the business of selling or importing nursery stock without having first obtained a license to do business in the State. Any person may obtain a license from the State Horticultural Commission upon the payment of a fee of \$2.50 annually and by filing with the State Horticultural Commission a bond in the sum of five hundred dollars (\$500). Each salesman or agent must hold a certificate giving his name and the name and address of the persons he represents, together with the license number of his principal. A copy of the certificate of inspection must be attached to each shipment. All nursery stock will be quarantined on arrival and, if deemed necessary, disinfected or destroyed at the cost of the owner. J. Edward Taylor, State Inspector, Salt Lake City, Utah.

Vermont. Nursery stock transported into this State for delivery therein must be accompanied by a certificate of inspection from a duly authorized nursery stock inspector of the State from which the consignment is made and the name and post office address of the consignor and consignee. M. B. Cummings, State Nursery Inspector, Burlington, Vermont.

Virginia. Before shipping stock into this State it is necessary to procure from the Auditor of Public Accounts, Richmond, Virginia, a certificate of registration, the fee for which is twenty dollars (\$20.00). Duplicates for agents' use are free. (Send certified check or draft for \$20 drawn payable to the Treasurer of Virginia.) In addition outside nurserymen are required to file a duplicate certificate of inspection from their local State Entomologist with the State Entomologist of Virginia, who will furnish tags at cost. One tag must be attached to each package of stock sold in the State. W. J. Schoene, State Entomologist, Blacksburg, Virginia.

Washington. No person, firm or corporation can engage in or continue in the business of selling, as agent or otherwise, within this State, or importing, nursery stock, without first having obtained a license. Application therefor must be made to the Commissioner of Agriculture and a satisfactory bond in the sum of one thousand dollars (\$1,000) must be filed with him; each bond must be renewed every year. The license fee for nurserymen and tree dealers is five dollars (\$5.00) per annum; for agents one dollar (\$1.00). All licenses expire one year from date of issue unless renewed upon the same as originally provided for. Every person licensed to do business in the State must notify the State Commissioner of Agriculture and district inspector of his intention to ship nursery stock, giving the name and address of the consignee. Hon. J. H. Perkins, State Commissioner of Agriculture, Olympia, Washington.

West Virginia. Each shipment of nursery stock into the State must be accompanied with an official certificate of nursery inspection, and in addition, the official permit tag of the State. Tags are issued at cost upon acceptance of the certificate of the shipper, and after the State certificate of registration has been procured. This is issued by the Auditor of State at Charleston, West Virginia, upon payment of a registration fee of five dollars (\$5.00). Transportation companies are required to notify the State Entomologist of all shipments of nursery stock entering the State and give the names and address of the consignor and consignee. W. E. Rumsey, State Entomologist, Morgantown, West Virginia.

Wisconsin. All shipments of nursery stock into the State must bear certificates of inspection and certificate tags. Transportation companies are forbidden to deliver nursery stock unless accompanied by certificate tags. Nurserymen or dealers desiring to sell stock in the State must secure a Wisconsin State license by filing a duplicate of their State inspection certificate with the State Inspector and enclosing five dollars (\$5.00) to cover cost of license. All nursery agents canvassing in the State must carry an agent's duplicate license, furnished for one dollar (\$1.00). Wilful misrepresentation of nursery stock is considered a misdemeanor. Prof. J. G. Sanders, Entomologist and Chief Nursery Inspector, Madison, Wisconsin.

Wyoming. Any person or firm wishing to do business in this State must first obtain a license. Licenses are issued on application for a period terminating on July 1st of the next succeeding inspection year (approximately two years). All applications must be accompanied by the license fee (\$25), a bond in the sum of five hundred dollars (\$500), conditioned that the principal will faithfully obey the law of the State of Wyoming, and by a certificate of inspection from an authorized inspector in the State from which shipments are to be made. On receipt of these papers, the Secretary of State Board issues authorized shipping tags (at cost). Nursery stock may not enter the State and transportation companies may not deliver unless such tag be attached to each and every box, bundle, or bale. The presence of the shipping tag shall be taken as prima facie evidence of inspection, and no further inspection is required, though the Board reserves the right to re-inspect, if for any cause it may deem it wise to do so. It is the duty of every outside nursery, holding a license to do business in Wyoming, to notify the secretary of the board, as inspector-in-chief, of every considerable shipment of nursery stock that it proposes to send into this State, said notice to reach the secretary at least five days before the delivery of the said goods, and to state the kind of stock included and the probable time of its delivery, the railroad station and the name of the consignee. It is the further duty of each nursery to file with the secretary the full address of every agent or solicitor it may employ in the furtherance of its business in the State. For circular of detailed information, address Mr. Aven Nelson, Secretary of the State Board of Horticulture, Laramie, Wyoming.

Canada. Nursery stock entering Canada must be imported through the following ports, during the periods mentioned, at which places the stock is fumigated:

Vancouver, B. C., from October 1st to May 1st.

Niagara Falls, Ont., from October 1st to May 15th.

Winnipeg, Man., North Portal, Sask., and St. John, N. B., from March 15th to May 15th and from October 7th to December 7th.

Windsor, Ont., and St. Johns, P. Q., from March 15th to May 15th, and from September 26th to December 7th.

No stock can be taken out of bond without a fumigation certificate.

The following stock is exempt from fumigation and may be imported at any time through any port without inspection: (a) Greenhouse grown plants, including roses in foliage which have been grown in pots up to 3 inches in diameter but not larger. **A certificate that the plants have been grown under glass must accompany the invoice and shall be signed by the consignor.** (b) Herbaceous perennials (the stems of which die down in winter), such as peonies, sunflowers, etc. (c) Herbaceous bedding plants, as geraniums, pansies, etc. (d) Bulbs and tubers, such as hyacinths, lilies and dahlias, irises, etc. (e) Cottonwood or Necklace poplar, when shipped from and grown in Dakota or Minnesota. The port by which it is intended that the nursery stock shall enter, must be clearly marked on each package. All persons importing stock, except that which is exempt from fumigation, must notify the Dominion Entomologist.

The importation of all nursery stock through the mail is prohibited. This does not apply to greenhouse-grown florists' stock, cut flowers, herbaceous perennials and bedding plants, which will be admitted provided that a detailed statement of the contents is attached to such parcels. The term nursery stock includes trees, shrubs, plants, vines, grafts, scions, cuttings and buds. Copies of the regulations or additional information can be obtained from Dr. C. Gordon Hewitt, Dominion Entomologist, Ottawa, Canada.

SPRAYING IN MINNESOTA

A. G. RUGGLES.

During the last four or five years, rather extensive spraying operations have been carried on in the fruit and potato regions of the State. These were designed to find the best spraying compound for the purpose, as well as the cheapest and the most economical method of using it. Some of the results obtained are incorporated in the following spraying notes.

As an insecticide for all leaf-eating insects, we have proved beyond a doubt that arsenate of lead is the best. One reason for this is that it sticks and hard rains do not wash it off immediately. Another reason is that, no matter how strong it is applied, it never burns the foliage. Many potato growers at the present time do not consider this the best potato beetle insecticide. The reason for such belief is that spraying operations are not begun until the grubs are present in large numbers. At this time a quicker-acting poison is thought necessary and Paris green does act quicker. If, however, the arsenate of lead is put on as the eggs are being laid and before many grubs hatch, a smaller number of sprayings are necessary and never does one get burning of the foliage. We therefore recommend its use at the rate of 3—4 pounds in fifty gallons of Bordeaux mixture.

In our orchard spraying work, we have given some attention to spraying before the leaf buds open in the spring and have found it of little value unless scale insects are present. The dormant spray used at this time is used chiefly against scale insects which are of very little consequence in many orchards; therefore we have not been advising its use except under special circumstances.

Three sprayings have been recommended:—the first given just as the blossom buds begin to show color; the second just after the blossoms fall; and the third spraying ten days or two weeks later. If brown rot of plums or black rot of apples or scab or leaf-eating insects are very abundant, a fourth spraying should be given four or five weeks later. The material used in each of these sprayings is arsenate of lead and lime sulphur. We recommend the commercial concentrated lime sulphur, diluted one gallon of the lime-

sulphur to forty gallons of water. Into this weakened lime-sulphur, two pounds of arsenate of lead paste are placed. Only one pound of the powdered arsenate of lead is used for this amount. In each case, however, the "lead" must be thoroughly mixed with a small quantity of the liquid before placing it in the spray barrel. This, if a good agitation is present in the spraying outfit, insures an even spread of the insect-killing material.

In some years, it often happens that from pressure of other work or from some other good reason, all the sprayings necessary for an orchard can not be given. If only one can be given, it should be the one just after the blossoms drop. This should be given in the most thorough way possible, thorough in its amount, in its covering quality, and its ability to force its way into the calyx cup of the fruit.

If, on the other hand, only two sprayings can be given, the one just mentioned and the one as the flower buds begin to show signs of opening are the ones recommended. It must be remembered, however, that it more than pays to give the three sprayings.

In our experience in spraying, over the State, a great deal of poor spraying has been seen. The material is put on the trees in a slovenly way; no attention is paid to the proper mixtures for the occasion and the spraying outfit is very often not fitted for the purpose. Spraying of this character is of very little value. The operator will very seldom get back any return for his money and will of course claim that spraying is not a paying operation. If any operation of the orchard requires careful thought and attention, spraying is one of them.

SOME IMPORTANT TREE INSECTS

A. G. RUGGLES.

During the last year, there have been many calls made upon the division for advice concerning tree insects. In all, about two hundred letters have been answered on this subject alone, besides the many telephone calls for aid. The relative importance of these insects is shown by the order in which the insects are mentioned below:

Bark borers, canker worms, cottony maple scale, spiny elm caterpillar, walnut *Datana*, yellow striped oak worm, scale insects, etc.

The injury done by the borers to the several species of oaks has been the subject of most inquiry. The insect causing this damage to the oak timber, called the two-lined chestnut borer (*Agilus bilineatus*), has been the object of close investigation this past summer and a number of new points have been brought out in its life history that may enable us to later find a better method of control.

For this locality in a normal year, the life cycle has been definitely determined as follows: The adult beetles fly from June 15th to July 15th, during which period the eggs are laid. The beetles are most numerous around July 1st. The eggs are laid singly or in batches of three to ten in the bottom of natural crevices in the bark. In ten days or more, these hatch and immediately bore into the bark until they reach the wood. After they burrow their length in the wood, they return to the growing layers between the wood and the bark, called the cambium, where all the injurious burrows are made. During the early stages of the grub life, the burrows are made with the grain of the wood or in an oblique direction. Later, particularly in the last stage, the burrow is almost always across the grain of the wood. It is at this time that the tree is being actually girdled. If the burrows extend far enough or if the grubs are numerous enough, the tree then dies.

In August the majority of the grubs have made their pupal chambers in the bark. In the spring, about June 10th, they pupate and adults are seen at the time mentioned before.



Bark removed from an Oak showing burrows of the Two-lined Chestnut Borer, *Agrilus bilineatus*.
A few larvae visible.

As these insects do their damage while completely concealed beneath the bark, very few natural enemies have been noted. We did, however, find two,—one an egg parasite belonging to the family *Trichogrammidæ* and the other a larval parasite belonging to the genus *Atanycolus*, both Hymenopterous parasites. These were determined by Messrs. Rohwer and Crawford. No further record was taken, although we expect to obtain more upon further research. Working as they do beneath the bark, no artificial remedy has yet been found to kill these pests while they work. As the life history shows, our only point of attack is while the beetles are laying eggs, a period of only one month. Although we have in mind a number of experiments, the only results obtained thus far have been with preventive remedies; that is, material put on the tree to deter the adult beetle from laying eggs. Experiments so far show that iron-sulphide or Bordeaux mixture sprayed on the trunks of trees discourage the visiting of such trees by the insects.

It has been found in our work that a relationship exists between these insects and a disease, the shoe-string fungus. Many times the borers have been found present with the disease. In some cases, the fungus alone was present and in others the insects alone. Whether the fungus is necessarily present, first acting as a primary cause of death to the tree or whether the combination causes death, is a question for further investigation.

Two insects very commonly asked about are the fall canker worm and the cottony maple scale. So much has been written about these that it is perhaps undesirable to take much space in this report. The fact remains that these insects can be successfully combated, but it requires absolute co-operation among all concerned in a community and long tedious effort. For literature on these insects, write to the Division of Entomology, University Farm.

Another insect doing considerable damage and new to the state is an oak twig-girdler. The work is entirely different from that of the oak twig-pruner and the difference is easily recognized. The tree seems to be infested with blight, many of the leaves on the ends of the small twigs withering. The damage is done by a small grub, a close relative of the two-lined chestnut borer. The adult has not yet been taken. As the life history is not known at the present time, only one method of combating the insect has been tried and no results have been obtained to date. This

method consisted in pruning the tips of all the infested branches on a tree and burning them. When the infection is abundant, this means a tremendous amount of work and it may not pay even if it proves an efficient remedy.

The poplar beetle has been doing considerable damage to the poplars and willows in the nurseries of the State. We are investigating the life cycle of this insect and propose to perform a considerable number of experiments on spraying against it. We believe that a thorough spraying at least twice during the season with arsenate of lead paste at the rate of 3 or 4 pounds to 50 gallons of water will be effective. So far, the most interesting phase of the work has been the discovery of a parasite, a *Tetrastichus* sp. according to J. C. Crawford, which destroys over sixty per cent of the grubs in certain localities.

The spiny elm caterpillar has done considerable damage to the elms and willows. Spraying with arsenate of lead 4 pounds in 50 gallons of water will keep them in check. A bacterial disease has been noted killing many of the caterpillars.

As mentioned in the article on spraying, scale insects in Minnesota have not, up to the present time, caused any alarm. To be sure, from time to time, the oyster-shell scale and scurfy barklouse causes considerable anxiety, but it is only rarely that these two scale insects have caused trouble. During the last year or so, however, the dread San Jose scale has made its appearance. With these three armored scales and perhaps more, capable of doing considerable injury and even causing death to orchard and shade trees, everyone must be on guard to stop the ravages of the pest in its incipency.

The remedy for all scale insects is the dormant spray of lime-sulphur. The lime-sulphur is the commercial concentrated material and is diluted in proportions of about one part of the lime-sulphur with nine parts of water. This is sprayed on the trees just after the leaves drop in the fall or in the spring before the buds swell. A warm day in midwinter is also suitable. Sometimes two applications are desirable. During the summer months no insecticide will kill the mature scales without destroying the foliage. However, if in each case the time can be definitely determined in which the young are crawling around in numbers, spraying with some contact insecticide like kerosene emulsion, dilute lime-sulphur or whale-oil soap will kill many and prevent serious injury until the dormant spray can be applied.



Spring Elm Caterpillars. *E. antiopa*, killed by bacterial disease

SOME NEW SUGGESTIONS IN FLY CONTROL

C. W. HOWARD.

The last year has seen several new suggestions put before the public for the control of house-flies. Most of these are designed to destroy the fly maggots in their breeding places with the least amounts of effort on the part of the individual.

The most recent suggestion is borax on manure. The United States Bureau of Entomology claims that the use of borax is the most effective, economical, and practical substance to use for this purpose. It does not seem to have any effect upon the manure, so far as their present investigations have gone, which would render objectionable its use as a fertilizer. The method in use is to apply borax at the rate of 0.62 of a pound to eight bushels (10 cubic feet) of manure immediately on its removal from the stable. The application must be made promptly as flies lay their eggs in the freshest manure. It is claimed that the presence of the borax prevents the eggs from hatching as well as killing the maggots. The borax must be applied more heavily at the outer edges of the pile as the maggots congregate there in greater numbers. Treatment must be repeated with each fresh supply of manure, unless the manure is kept in boxes or bins, when it can be applied less frequently. It will have the same effect upon other manures than that from horses and upon garbage and refuse. It may also be used on floors and in crevices and cracks about stables where flies sometimes breed. The cost is comparatively slight; if purchased in quantity, it should cost only about 5 or 6 cents per pound, and the Bureau claims that the average cost of using borax is approximately one cent per horse per day.

As soon as this recommendation of borax was published, we tried out some small experiments to ascertain its value on manure and garbage. We found that, while borax, without question, kills fly maggots, when it comes in contact with them, the difficulty seems to be to get it so distributed through the manure or garbage that the fly eggs or maggots cannot avoid coming into contact with it. This difficulty can be, to a large extent, overcome if the borax is thoroughly dusted over each lot of manure or garbage as it is added to the pile or bin.

On the University Farm, the past summer, we tested out the use of an arsenical spray for killing fly-maggots in manure. This spray had been originally suggested by Mr. M. P. Somes, and was taken up by the South Carolina Experiment Station in the summer of 1913. They found that a spray prepared as follows:

Arsenate of Soda.....	4 pounds
Molasses	2 quarts
Water	50 gallons

or, in these proportions for smaller quantities, would kill 98 per cent of the fly-maggots when sprayed over the manure so as to thoroughly moisten the surface.

This spray gave excellent results when used on our compost heap, but here again we met the same difficulty which we experienced in the trials with borax. It was difficult on a large heap of manure, to cover every fresh addition with the spray promptly and thoroughly, so that some maggots escaped destruction and some flies emerged from the pile which had to be destroyed by other methods. At smaller stables, where less manure is produced and where additions are made only once a day when clearing out the stable, spraying can be done more effectively. Arsenite of soda is very poisonous and must be kept out of the reach of children and of stock. The spray when applied to the manure need cause no fear as it does not detract from its value and poultry feeding about the pile suffer no harm.

The same objection may be made to both of the above methods; that is, the difficulty which the ordinary individual will find in making the applications regularly and with sufficient thoroughness. For this reason, it seems to the writer that the system of drawing out the manure daily or at very frequent intervals from the stable and spreading it upon the field is the most satisfactory one to employ.

Another suggestion made for the destruction of maggots in manure piles is the use of "maggot traps." These are based upon the fact that when the fly maggot is full grown and ready to transform to the fly stage, it leaves the warm and moist part of the manure pile and seeks the dryer and cooler outer edges and especially the soil surrounding and beneath the pile, where it passes through the resting stage. It was found that if manure in large cages was kept moist, 98 to 99 per cent of the maggots contained in it left when ready to pass through the transformation stage before becoming flies. Several styles of traps have been suggested by different writers. The essential details are to have

a large bin with a perforated bottom through which the maggots can find their way. Beneath the bin must be a pan or basin of metal or concrete, either containing an inch or more of a weak disinfectant or water, covered with oil, which will kill the maggots when they drop in. Such a basin should have straight, vertical sides, and if connected with a sewer, could be easily flushed out once a week. Much remains to be done to perfect such a trap for practical use.

We have had frequent requests from people wishing to know what they could use in order to clear a house of flies, after they have screened the doors and windows. Many substances have been recommended and it was difficult to know which was the best to advise. With this in view, several tests were made of these fumigants during the past summer. Fumigation with hydrocyanic acid gas would, of course, kill flies, but owing to the danger which might result from its use by an incautious person, it seems advisable not to suggest it. The cost is also prohibitive to most people. We tried the following, which are easily manipulated and the ingredients of which are easily secured: phenol-camphor, formaldehyde-gas, cresol, carbolic acid, sulphur, chlorine gas, and pyrethrum (insect powder). Only three of these gave satisfactory results.

Formaldehyde was used at the rate of one pound of 40 per cent formaldehyde with eight ounces of potassium permanganate, to each 1,000 cubic feet of space. When the room was left closed for four hours, it destroyed practically all of the flies. Out of nearly 2,300 flies, only twelve survived. Formaldehyde and potassium permanganate can be purchased at any drug store. The permanganate should be spread evenly over the bottom of a large enameled pan and the formaldehyde poured over it. Formaldehyde gas is liberated as a result of the chemical action which takes place. Where this gas is used for disinfection purposes, a considerable quantity of water is added to the formaldehyde before pouring it over the permanganate. A parallel experiment, however, in which water was used with the formaldehyde did not give us as good results, fully 10 per cent of the flies surviving. Before fumigating, the room or rooms must be made as nearly air-tight as possible by closing up all openings, plugging up cracks in walls and around windows, etc. After fumigating, the room must be aired out for a couple of hours before entering. An individual will, however, not be apt to enter a room full of formaldehyde gas,

as the irritation to eyes, nose, and throat is severe. After entering the room, the flies should be at once swept up and burned, to avoid the possible chance of any reviving.

Another substance which gave as good results as the formaldehyde is phenol-camphor, a compound used to kill mosquitoes in the yellow-fever outbreak in New Orleans a few years ago. It is far less offensive to the user than formaldehyde, but a little more trouble to prepare. Its preparation is as follows:

It consists of equal parts of carbolic acid crystals and camphor gum. The carbolic acid crystals can be liquified by heat, and then poured over the camphor gum. When moderately heated, this mixture gives off dense fumes which rapidly diffuse. They soon condense and settle on all exposed surfaces as a light moisture. The effect of these fumes upon flies is somewhat the same as that of pyrethrum but more certain in its effects. The flies, however, should be swept up afterward and destroyed. The fumes are irritating and produce symptoms of phenol poisoning in some people. This camphor-phenol mixture has an advantage over pyrethrum in the material being less in bulk and the rooms may be entered after an hour, thus enabling one to make a quicker application. Four ounces of this mixture should be used to every thousand cubic feet of space and the exposure should be for two hours to secure best results, after which time, doors and windows may be opened. Not more than eight or ten ounces of the camphor-phenol should be placed in a basin, preferably an agate wash basin. It is vaporized by heat and can be placed over a lamp or other flame, at such a height as to volatilize rapidly but not overheat the dish and cause the contents to take fire. If a small alcohol lamp is used, the basin should be placed over a piece of stove pipe which has been so cut as to form legs at the bottom and to bring the basin ten inches above the flame. Punch a series of holes just below the top of the pipe to provide a draft.

Chlorine gas generated by pouring sulphuric acid over chloride of lime gave excellent results. We used four ounces of lime for each 1,000 cubic feet of room space; five ounces would be better. To each ounce of chloride of lime was added two fluid ounces of sulphuric acid. This was done in an enamelled pan. Owing to the dangerous nature of chlorine gas, however, we do not feel like recommending it as a fumigant except for those who are familiar with the handling of chemicals.

Experiments with the use of carbolic acid, creosol, sulphur and pyrethrum did not give satisfactory results.

WARBLE FLIES

C. W. HOWARD.

Until the spring of 1914, the pest of cattle, known as ox-warbles or warble-flies, seemed to have been absent from Minnesota. But at that time, three cases of infested cattle which had been shipped in from other states, came to our attention. The injury to cattle is caused by the grub stage of the insect which lives in large tumors under the skin on the back of the cattle. When numerous, the loss due to the weakened condition of the cattle, as a result of the presence of these warbles is very considerable. At the Union stock yards, Chicago, it is estimated that during the grubby season, fully 5 per cent of the cattle received are grubby and the accompanying perforation of the hides by the grubs lessens their value on the market. When the flies are laying their eggs upon the hair of the cattle, the fretting and stampeding cause a loss in milk and beef. Osborn states that, considering the animals' comfort as a mere matter of sentiment, it is fair to estimate that the average annual loss in the United States from this insect should be reckoned at \$1.00 per head. Using the census of 1910 as a basis, this would give us a loss of \$69,000,000 annually. These flies are present in the greater part of the eastern and middle-western states and Canada. Apparently, Minnesota is an oasis in the center of an infested area. For this reason, great care must be exercised to prevent this pest being brought in from neighboring states and obtaining a foothold here. The three importations last spring to which we have referred, came from Massachusetts, New York and Wisconsin.

The fly which produces these warbles is one of the bot-flies and resembles slightly a large, dark-colored bee in general appearance. They appear early in spring and last well on into summer, from March until July being the months of appearance. The eggs are placed on the hairs of the legs, preferably in the region of the hock and back of the knee. The fly is not provided with a sting and its mouth-parts are rudimentary, so it is unable to do any injury to the cattle, but when depositing an egg, strikes the

animal in a clumsy manner. For this reason, they seem to recognize it as an enemy and become very nervous and excited,

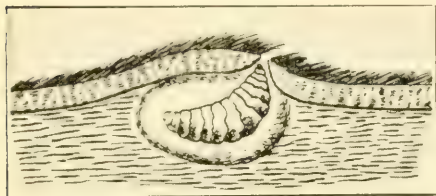


FIG. 6. Vertical section of hide and subjacent tissue, showing oxwarble in position, Diagrammatic. Courtesy of Country Gentleman.

racing pell-mell about the fields in an attempt to escape from it. It was formerly thought that the fly inserted its egg in the skin on the back or placed the eggs so that the grubs could work their way through the skin, but this is now disproved.

When the young grubs hatch from the eggs, they are licked up by cattle and carried into the mouth. From there they migrate into the gullet and bore into its walls. Part of their development takes place here. Some observers have found them in the spinal canal and pancreas. How the migration takes place we do not know, but about January they suddenly appear under the skin on the back, forming swellings or tumors. A small opening is made through the hide, which is enlarged as the grub grows, until in spring it may have a diameter of one-quarter of an inch. The posterior end of the grub is forced against this opening and it is thus able to breathe and to discharge its excrement to the exterior. By spring or early summer, the grub is fully grown and working its way through the opening in the hide, falls to the ground, into which it burrows and transforms to the pupal stage. About a month after this the fly emerges.

The flesh in the vicinity of the grub becomes slimy and of a greenish color and is known as "licked beef." This is another cause of loss as the consumer is apt to be prejudiced against the use of such beef.

The treatment for warbles is fairly easy. In late winter and spring, examine the cattle for the presence of the tumors. They can be readily felt by passing the hand over the back. The size of the tumor can be imagined when it is known that the full-sized grub may measure $1\frac{1}{4}$ inches in length. If the grubs are full-grown and nearly ready to emerge, they can be forced out through the opening in the skin with very slight pressure. If they are not full-grown, it is more difficult to remove them by squeezing, but frequent examinations will make it possible to secure each one. Care must be exercised to crush each grub as soon as removed so as to avoid the possibility of any reaching the soil and eventually producing adult flies.

Another method of removal is to force grease or oil into the openings of the tumors and thus kill the grubs. Recently it has been stated in Europe that the injection of one-half to one cubic centimeter (20 to 40 drops) of tincture of iodine into the tumor will kill the grub. It has also been claimed that the use of repellants such as some of the oily washes or sprays so often recommended to keep flies from cattle and horses, will prevent the flies from laying eggs on the animals. It is also thought that the use of arsenical dips as employed for tick destruction in the South will reduce the number of grubs.

It is still open to question whether any remedy is so effective as that of squeezing out and crushing the grubs in spring. Where the herds are of such a size as to make it possible to give systematic supervision and examinations to cattle, it is possible to reduce the flies to their minimum numbers if not to entirely exterminate them in one or two seasons. Success in a community, of course, involves team work on the part of everybody.

Considering the losses which will follow its introduction into Minnesota, it will be well for everyone importing cattle to watch carefully for these warbles and see that they are exterminated on those animals, if they are found to be present. Their distribution through the State will cause inestimable loss.



FIG. 7. Method of squeezing out "grub."
Courtesy of Country Gentleman.

TRUCK CROP INSECTS

WM. MOORE.

During the year 1914, work on several different projects was carried out by this section beside the general breeding work of the insectary. The factors influencing the successful fumigation of greenhouses with hydrocyanic acid gas as a means of controlling insect pests were studied, but as this work was rather technical in character and has neither been completed nor the practical applications determined, it would be inadvisable to report on it at this time.

White Grubs: During the spring, it was noticeable that large numbers of June bugs or May beetles were emerging. They were abundant about the lights and in many places, attracting considerable attention from various people. As the larva of the June beetle is the common white grub, which is so injurious to farm and truck crops, ornamental plants and in the lawn, an effort was made to determine which species would emerge this year and in what parts of the State. Four species were found to be particularly abundant: *Lachnosterna fusca*, *Lachnosterna rugosa*, *Lachnosterna dubia*, and *Lachnosterna grandis*.

The result of this work is shown in the accompanying map. Due to limited funds, it was impossible to travel extensively over

the state, so that in collecting data wherever possible, it was requested that people send in a number of specimens. A few night trips were taken through the State but, unfortunately, no data was obtained from the lower tier of counties. Although it was known that in Jackson County the beetles were abundant, no specimens were obtained. *Lachnosterna fusca* and *rugosa* seem to be generally distrib-

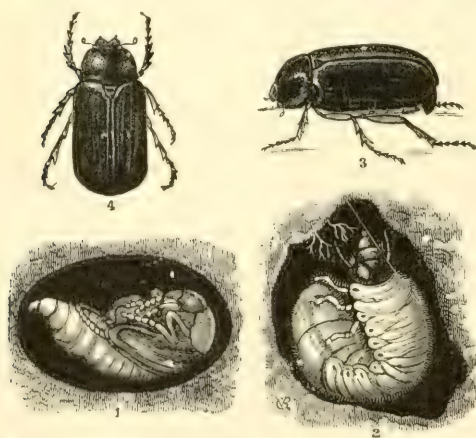


FIG. 8. *Lachnosterna fusca*, Froehl. 1 pupa 2 larva, 3 and 4 imago. Bu. Ent. U. S. Dep. Agriculture.

uted over the southern part of Minnesota but do not extend much beyond the middle of the State; *dubia*, which is very similar to the two preceding, has been found as far north as Kittson County and as far south as Brown County. *Dubia* and *grandis* may be termed the northern species. *L. grandis* is probably the species injurious to seedling trees in nurseries in the northern sections.

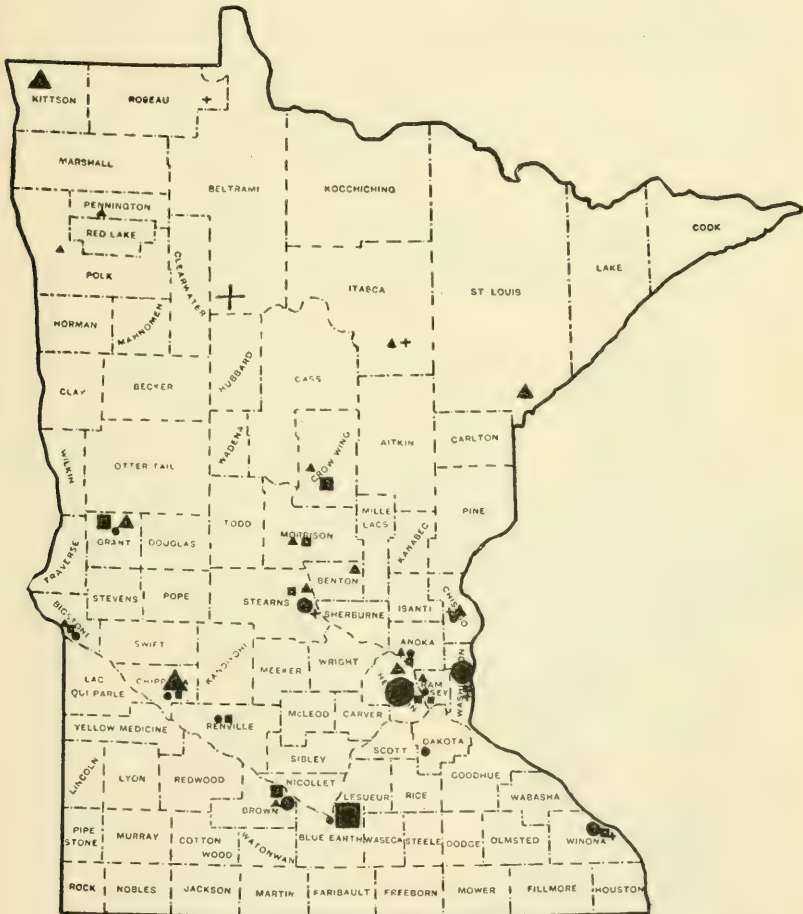


FIG. 9. Map of Minnesota showing distribution of *Laahnosterna dubia* (triangle) *L. grandis* (cross) and *L. rugosa* (square.) W. Moore.

From the above data, it will be seen that the June beetles—at least one or more of the four species—were abundant in almost all parts of the State during the last summer. Probably even in those places not marked on the map, the beetles were abundant

but, owing to lack of funds, it was impossible to make a complete survey. The beetles feed upon the foliage of various trees during the night time and hide in the soil during the day. They lay their eggs in the soil, particularly that which is in grass or similar crops and not well cultivated. Well-cultivated fields planted in crops such as potatoes or corn, probably had few eggs laid in them. The fields nearest to trees or woods would have more eggs than other fields out in the open. These eggs hatch into small white grubs during the summer and after passing the winter, they will be particularly abundant next year and destructive to such crops as corn, strawberries, potatoes; in fact, to most any crop planted in hills; and it also may prove very destructive to lawns.

As it is impossible to successfully deal with the white grubs after they have started their injury, it is necessary for the farmer to plan his work and his planting in such a way as to avoid white grub injury.

Notices have been sent out at several times during the summer to farmers, advising them of the approaching attack of white grubs. Some farmers have probably fall-plowed their land which is the first step for avoiding injury. All land which has been in sod, and particularly if it is near woods, is apt to be infested. If it is intended to plant crops in hills during the next summer in such fields, they should be fall-plowed. At the time of plowing, the farmer can readily determine if his fields are severely infested. Thirty to forty grubs turned over to each quarter-mile of furrow will mean a severely infested field next spring and hogs should be turned into such fields to root out the grubs. Such crops as are most susceptible to injury should be planted in fields not severely infested. Other crops, such as grain, buckwheat, clover, etc., should be planted on the infested land, as these suffer but little from the attack of white grub. Farmers throughout the State should plan their work now and carry it out next year, in such a way as to avoid injury from white grubs.

If the farmer has failed to fall-plow grass land and, on plowing it in the spring, finds it infested with white grubs, he should not plant it in corn or other susceptible crop. In the case of lawns where it is impossible to plow, very little can be done. A recent bulletin from Michigan mentions a bacterial disease of white grubs which is considered to be rather wide-spread. If this is present in grubs in the lawn, it could be encouraged in its work

of destruction by wetting the lawn thoroughly as the disease rapidly develops under humid conditions, killing off the grubs. Tobacco extract is also of value in destroying grubs in the lawn. A quickly available fertilizer is of value in enabling the plants to recover.

The grubs will be bad during next summer and during the early part of the summer of 1916 and will emerge again as adults in great abundance in 1917. Unfortunately, it is difficult for the farmer to realize that he should destroy these June beetles to save his crops from an attack of white grubs. A very few no doubt have been collected and destroyed by the farmer at the time they were abundant during the last year.

To show the value of what could be done: on June 1st the author and two assistants collected in one hour's time, in Stillwater, around the electric lights, 1,928 beetles, of which 1,424 were females, with an average number of 52.7 with eggs which had not been laid. By the destruction of these beetles, it can be estimated that nearly a million eggs were destroyed which would have produced a million young white grubs.

Cabbage and Onion Maggots: Two other insects which attracted considerable attention during the summer were the cabbage and onion maggots. They are of increasing importance each year in Minnesota and although work was started to advise a new treatment for these pests, it has not continued far enough to publish satisfactory results. By another season no doubt more satisfactory results will be obtained. Notes on this work were published in Minnesota, *Insect Life*, August, 1914.



FIG. 10. Melon leaves curled by attacks of lice.
Chittenden, Bur. Ent. U. S. Dep. Agr.

Melon Lice: Many inquiries were received during the summer concerning lice on melon vines. In almost all cases, at the time the lice had been noticed on the vines, and reported, it was too late to give a satisfactory treatment. For this reason, a few notes on the melon louse may be advisable.

The success of the treatment of the melon aphid depends upon how soon after the vines become infected they are discovered and treatment started. Farmers growing melons should examine their vines about the time that they send out their runners. By looking on the under side of the leaves, the aphid can be easily discovered while in many cases, their presence is plainly shown by the curling of the leaves. Frequently it will be found that only one or two vines in a field are infected. These should immediately be taken out and destroyed by burning, thus preventing the spread of this aphid to the other plants. If a larger number of plants are infested, they can be fumigated with carbon bisulphide or tobacco paper. A wash-tub or similar air-tight box should be inverted over the plant and a teaspoonful of carbon bisulphide used for each cubic foot of space enclosed. This treatment gives satisfactory results but recently it has been found that burning tobacco paper underneath the tub or box gives more satisfactory results. From one-half or one sheet of tobacco paper, according to the brand which is being used, should be burned under each tub or box. It is usually torn into one or two pieces and placed in perforated tin cans on opposite sides of the frame and ignited. Fumigation lasts for from ten to thirty minutes, according to the strength of the paper used. If melons are grown extensively, frames made of muslin which have been painted over with oil to make them gas tight, can be used. One man can handle about ten such frames. At this rate, the work is rapidly carried on. If the aphid is not treated early the plants become too large to fumigate economically and as the leaves are curled, it is impossible to spray them successfully.

Cucumber Beetle: During the summer, a graduate student, Mr. C. A. Sell, carried on some successful experiments upon the cucumber beetle. He was able to show that one teaspoonful of Nicofume or similar tobacco extract to each gallon of water makes a solution which is strong enough to kill larvae of the beetles on the under-ground portions of the cucumber plant, the stage found most destructive to cucumbers in cold frames. A cupful of the mixture is applied to each plant and at this rate, treatment costs about 40 cents per hundred hills. Further details of his work will be published during the winter in a circular of this department.

* Work based upon data furnished by Mr. Frank Gibbs.

WIREWORMS

WARREN WILLIAMSON.

During the past season, many reports have been received of injury by wireworms to seed corn after planting and to young corn plants as well as some damage to wheat, barley, and potatoes. Among the localities suffering injury to corn were Blooming Prairie, Fairmont, Fulda, Litchfield, Montevideo, Owatonna, Rushmore, Sherburn, Tracy and Verdi. Damage to potatoes occurred at Chatfield and Faribault and to wheat and barley at Owatonna. The amount of injury to corn in fields where the infestation was severe, as estimated by the owners, varied from one-fourth to one-half of the crop. In one report of injury to potatoes, the owner estimated the loss at half the crop.

Corn is injured in several ways. The wireworms may burrow into the planted kernel, often devouring it completely. Other points of attack are the roots of the young plant which are eaten so that it may be dwarfed or even killed. The underground portion of the stalk is frequently tunneled so that the plant dies. The effect in a badly infested field is seen in a large number of missing hills and dwarfed, unhealthy-looking plants. Wireworms are most numerous in corn on ground that has been in grass for several years, and are more likely to cause the worst injury the second year after breaking up from sod. Usually, but not always, it is in the lower parts of the field that the corn suffers most. Injury to potatoes is done by the wireworms tunneling into the tubers or gnawing the skin. It is said that they will occasionally bore into the stalk. We have had reports of a continuation of the work in the tubers after storage. Wheat and other small grains are killed by the destruction of the roots. While the above-mentioned crops are the only ones reported this year as suffering injury in Minnesota, it is known that wireworms will attack other plants such as turnips, beets, onions, lettuce, strawberries, and numerous garden flowers. Being originally natives of wild prairie sod, they find a suitable habitat in grass lands where they feed upon the roots of grass, but rarely in sufficient numbers to do noticeable injury. When deprived of such food, as occurs in a cultivated field, they

concentrate on the comparatively few plants of corn, potatoes, or small grain.

Wireworms are the larval stage of various species of beetles belonging to the family Elateridae. The latter are popularly known as "click beetles," "jumping jacks," or "jack snappers," on account of their peculiar habit of springing into the air with a clicking sound when placed upon their backs.

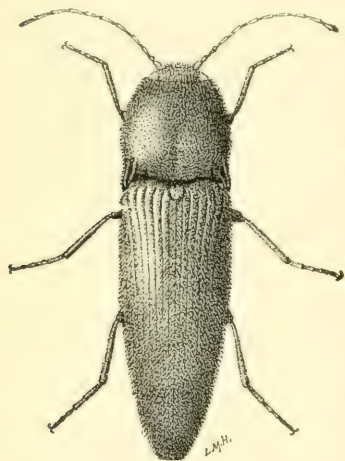


FIG. 11. A common click beetle, *Melanotus communis*. After Forbee.

While we have found no records showing that the life history of any of our Minnesota species has been completely worked out, the following general statement will apply to practically all that are of economic importance. It is believed that the eggs of our common species are laid in the soil in the spring by the beetles soon after they emerge from hibernation. The larvae remain in the soil at least two years. In this fact may be found the explanation of the greater damage done to corn the second year after sod. The grass roots are not all killed the first year so that the wireworms are not

forced to concentrate upon the corn as they do the following season. When full-grown, the wireworms are about one inch long, slender, and of equal diameter throughout their length, distinctly segmented, yellowish or brownish in color. They have three pairs of legs and an additional foot or prop on the last segment. This last segment is of peculiar form, being lobed, toothed or notched, according to the species, and is of use in separating the different species. Their hard, smooth, cylindrical bodies and the vigor with which they bend and wriggle when held in the fingers probably accounts for the name "wireworms." From midsummer onward the full-grown larvae form cells in the soil where they pupate. After about one month passed in the pupal stage, they transform to beetles, the majority of which remain in their earthen cells until the following spring. The adults of our injurious insects are about one-half inch in length, elongate-oval in form, brown in color, and readily distinguishable by the springing habit previously mentioned. The body is loosely jointed between the prothorax and mesothorax. When placed on its back, the beetle straightens its

body, then by the contraction of powerful muscles, the anterior part of the body is bent upward with such force that the insect is hurled into the air. If it does not alight on its feet at the first attempt, it tries again.

Among the natural enemies of wireworms are the predaceous ground beetles and several species of birds including robins, crows, and shore birds.

Wireworms are rather difficult to control for the reason that nearly all of their work is done underground. The following methods of treatment have been recommended by workers in other states, although we have not tested them experimentally in Minnesota. If old sod that is infested by wireworms is to be broken up, the plowing followed by a thorough harrowing should be done in the late summer or early fall. At this time, the full-grown wireworms have changed to the pupal stage when they are delicate and easily killed. If any of the pupae have transformed to beetles, these are sure to be in a more or less helpless condition. In addition to killing some of them directly, the plow and harrow will turn many of them up to the surface and break their earthen cells so that they will be exposed to the weather and natural enemies. Pasturing with hogs previous to plowing would help to destroy many of the wireworms as well as white grubs, cut

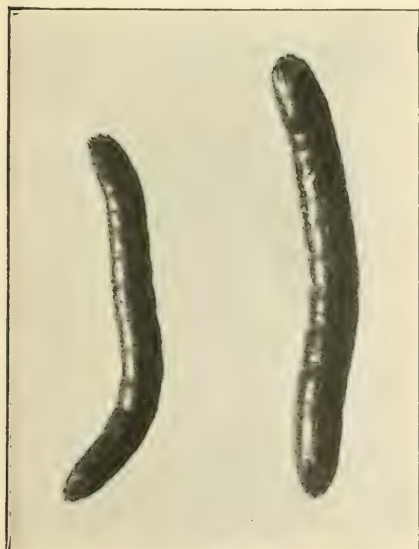


FIG. 12. Wireworms, larvae of *M. communis*.

worms, and other grass-eating insects. If the sod is followed by two years of clover before planting to corn, the danger to the latter crop would be greatly diminished. If the clover is sown with a nurse crop of small grain, the latter might suffer some injury from the wireworms, but not as seriously as corn. In addition to fall-plowing, the practice of clean cultivation and a short rotation in which the land is not allowed to remain in grass for a long time will help to keep the pest in check.

If the attack of wireworms makes it necessary to replant

corn, it might be worth while to try the following method of treatment for seed.

Dip the seed in tar as is done to protect it from crows; then dust it with a mixture of road dust and Paris green, using enough of the latter to give the dust a green color. Allow the seed to dry before using. This treatment will not interfere with the operation of the planter nor prevent the seed from germinating.

The localities which suffered most this season may not be troubled much again for two or three years. The majority of the wireworms that were found were full grown and will emerge as beetles next spring. Eggs will then be laid but the young larvae will not become large enough to cause serious injury next year. In the following season their work may become apparent. These things should be remembered when planning a cropping system for the next two or three years.

INSECT LIFE

Complete Index of Vols. I and II.

(From June 1, 1910, to August 1, 1914, inclusive; compiled by O. J. Wenzell.)

The initial copy of *Insect Life* was issued in June, 1910, but since that date our first number each season is mailed on or about April 1st. The object of the publication is to place before farmers, nurserymen, fruit-growers, gardeners, and housekeepers timely items which we hope will be of value in suggesting methods of preserving property from the attacks of insects. It is not purported to be technical, nor does it necessarily publish methods originating in this Department, though much of the material is the result of personal investigation. The mailing list is increasing and many letters approving the publication have been received during the past two years. *Insect Life* is intended primarily for distribution within the State, and is mailed free to any citizen of the State requesting it. [F. L. W.]

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PRELIMINARY NOTES ON THE ODONATA OF SOUTHERN MINNESOTA

A. D. WHEDON, MANKATO, MINN.

Introduction.

The dragon-flies have always attracted attention. Due to their form, life history and habits they have been the center about which grew up myths, superstitions and poetry on the one hand, and on the other a fundamental branch of biological science. Not being known, however, as insects of great economic importance their study by American entomologists came rather later than in Europe. In 1861 the Smithsonian Institution published a "Synopsis of the Neuroptera of North America," written by Dr. Hermann Hagen of Königsberg. The first important work by an American author was Calvert's "A Catalogue of the Odonata of the Vicinity of Philadelphia, with an Introduction to the Study of This Group of Insects," published in 1893. In 1899 a posthumous paper on the "Dragon-flies of Ohio," by Professor David S. Kellicott, appeared, edited and completed by Mr. J. S. Hine. Stimulated by these papers or by contact with their authors, several entomologists issued state faunal lists, the best known being those of Williamson for Indiana (1900), Needham for Illinois (1901) and New York (1901 and 1903), Calvert for New Jersey (1900, 1903 and 1909), Walker for Canada (1908) and Muttkowski for Wisconsin (1908). It might here be mentioned that the writer has been at work on the Iowa fauna since 1900, though the results are not yet published, and that for the past three years considerable collecting has been done in southern Minnesota. Wilson's "Dragon-flies of the Mississippi Valley" (1909) records species collected on the river.

In other than faunal lines the most important Odonate studies undoubtedly have related to wing venation. The principles discovered in the study of the dragon-fly have been applied to insects generally. This task was attempted by Professors Comstock and Needham and extended and further illuminated by the latter in his "Genealogical Study of Dragon-fly Wing Venation," 1903. The effect upon every line of entomological work has been immeasurable.

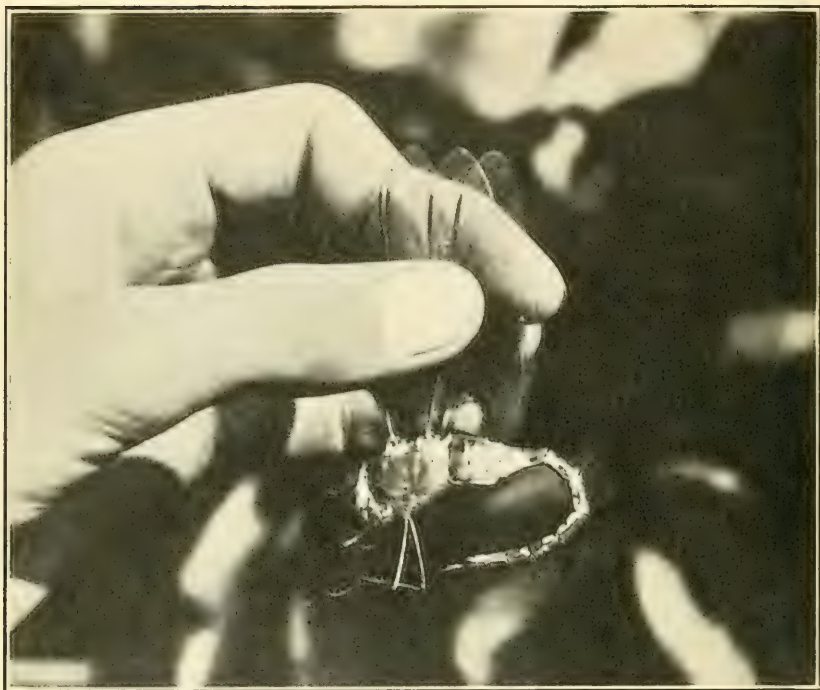


FIG. 13. *Anax junius* assuming defensive attitude. Dragon flies, however, do not sting. Photo by A. D. Wheden.

Again Professor Needham's work in Illinois and New York upon the life histories and the nymphs of the dragon-flies has stimulated new interest in a neglected phase of the work on this order, most of the papers having dealt with the adults only. Among the many who have since added to the results of Calvert and Needham none has done more than Dr. Walker during his study of Canadian species and in his revision of the genus *Aeshna*.

To aid us in clearing up the whole history of the group have come several European writers on fossil insects, Handlirsch in the lead, with descriptions, illustrations and classifications of fossil Odonata. In America Professor Cockerell has unearthed several very interesting forms which have been carefully studied by Dr. Calvert. Professor Needham also made very considerable use of accessible Odonate fossils in his paper on wing venation.

Thus, from a biological point of view at least, the progress made during the past score of years in our knowledge of American dragon-flies is of significance. On the one hand general principles have been

added to the science of life, and, on the other, a group of beautiful insects has been systematized and placed beside the Lepidoptera and Coleoptera for purposes of more popular study.

The Life Cycle.

All aquatic organisms are especially interesting because they are nearer to the primitive and generalized products of evolution than are their more highly specialized terrestrial relatives. Not only did all life begin in the water but the seas were the early battle grounds of hosts of evolving races. For ages before the barren lands were clothed with vegetation, myriads of armored animals patrolled the waters, rending one another in continuous carnal warfare and laying the foundations for the changes to come. We read in the records of those times the chapters of phylogeny, but yet more, our science and philosophy seize upon forms which in the present day have risen only to the lower levels of organization, and make them contribute what they may possess to our perspective. And further, if to this lower stage of existence an animal adds a transformation to the terrestrial or aerial, and all in one life cycle shows us the primitive aquatic cell, the armored and predaceous Paleozoic monster and the best and swiftest aerial mechanism the world has ever known, our interest is more than doubled. This is true of the dragon-flies.

The story of the development and transformation of the dragon-fly has been so frequently told that its treatment here will be brief. The cycle begins with the laying of the egg, either in the water or in some partly submerged stem, or even upon masses of floating plant debris. The eggs of different species vary in shape from elliptical to nearly spherical, and are usually a millimeter or less in length. Upon contact with the water the gelatinous covering becomes swollen by absorption and in some genera, as *Tetragoneura*, takes the form of a thread not unlike the egg strings of the toad.

The egg hatches in a few days and there appears a curiously armored little nymph with large head and abdomen and a weak thorax bearing the six long, slender legs. The head is dorsi-ventrally compressed and accommodates a pair of rather large eyes, some short antennae and a remarkable labium. This latter is arm-like in structure with its distal or lip portion supplied with a pair of strong mandible-like appendages. When extended for grasping prey it reaches out several times the length of the head; when retracted the arm is folded beneath the head and thorax with the terminal portion arranged

like a mask over the face. The wings are represented by wing-pads which enlarge as the successive moults occur. The more external organs of respiration differ in the two sub-orders, the damsel-flies breathing by means of three terminal caudal gills and the dragon-flies by drawing water into a highly modified rectal chamber, exchanging gases and again pushing the water out.

The nymphal stages last in different forms from two to four or five years. In *Eeshna* Walker's observations indicate that about a dozen moults are accomplished. At each of these periods changes in form and the development of systems can be noted. During the months or years thus occupied the nymphs spend their time in capturing food, some searching the debris at the bottom, some burrowing in the mud or sand and others climbing amongst the submerged vegetation.

For a week or two before the last moult, which is to end its aquatic existence, it is quiescent and eats little or nothing. Internal changes are occurring with great rapidity and certain of them can even be seen from the exterior, as the withdrawal of the adult labium from that of the nymph. When reorganization is completed the nymph crawls out of the water and clings to some support until its cuticle dries and splits across the head and down the back of the thorax. Within ten to twenty minutes the head, thorax, legs and wings may be free from the larval shell. At this stage there is usually a rest of several minutes, followed by the freeing of the abdomen as the imago clings to the shell or exuvia it is abandoning. All parts of the body are now extended or expanded to their proper adult proportions, the wings changing most remarkably, and the process of hardening or chitinizing the cuticle begins. If weather conditions are favorable and no calamity in the form of bird, frog, fish or larger dragon-fly appears, the imago may be ready for flight in a few hours; the colors do not mature completely for some days, however, and the reproductive system requires a still longer time for development.

Thus the day of feeding is not past, as is practically the case with many other insects, and they spend their time for a month, more or less, in devouring the Diptera and small insects about the pond or stream from which they recently emerged or over neighboring pastures or roadsides.

When sexual maturity is attained pairing and ovipositing become the paramount issues. There seems to be little if any courtship in the Odonata, and struggles between males for the possession of the female are rare. There are, however, apparent exceptions to the latter statement: Kellicott believed that *Calopteryx* and *Hetaerina* generally

possess this habit. "Two combatants will fly about each other, evidently with consuming rage, when one finally appears to have secured a position of advantage and darts at his enemy, attempting, often successfully, to tear and damage his wings." Everyone who has watched *maculata* has also observed this repeatedly, no doubt, and has wondered at the frequency of these "free fights" during which each male does his best to disable indiscriminately any or all of the rest of his kind in the gathering crowd. Few fatalities seem to occur, but the stronger may possibly tire out the weaker ones and then seize and carry off the females. Often a whole group of quarrelsome males may be netted at once, so preoccupied are they. In the case of *Aeshna*, where the sexes are very much alike, it is Walker's opinion that nothing of the kind occurs and that pairing is even attempted, though prevented by the mutual inadaptability of the genitalia, between males and females of different species. He even records attempts of males to copulate with males and in one instance found three individuals, two males and a female, in tandem. In *Plathemis lydia* and, to a lesser extent, *Libellula pulchella*, the writer has often observed momentary conflicts between two or more males which were trying to gain possession of a single female.

Space does not allow of a summary of observations upon modes of copulation, but it is in general true that the prothorax (*Agrionidae*) or the back of the head (*Aeshnidae* and *Libellulidae*) is clasped by the terminal abdominal appendages of the male, often so vigorously as to leave distinct scratches or dents upon the eyes or the back of the head of the female (*Anax*, *Aeshna*, *Gomphus*, etc.). In *Argia moesta putrida*, Walker has described a condition of mutual adaptation of sexes so close that once firmly clasped, the female can prevent the male from escaping as long as she so desires. It would not be surprising to find this true of most damselflies; it is not at all uncommon to see the males accompanying ovipositing females of *Enallagma*, *Lestes*, etc., in full flight activity but apparently anchored by the female, who works half-submerged upon some stem. The writer has observed the males of *Enallagma hageni* drawn thus beneath the water.

Following the capture of the female, the pair either engage in a wild nuptial flight (many *Anisoptera*) or settle down upon a rush or weed stem (some *Anisoptera*, and *Zygoptera*); while in this condition the female bends the abdomen forward and applies the vulva to the male genitalia of the second abdominal segment, the spermathecae of which has been filled previous to pairing. When copulation is completed oviposition immediately ensues, and during this later process it is not

uncommon for the male to retain his hold upon his mate. In fact, copulation and oviposition are often repeated without an intervening separation of the pair. The male may be of use in aiding the female to evade the sudden dash of an enemy.

The mode of oviposition differs with the groups: in the *Agrionidae*, the *Aeshnidae* and the *Cordulegastrinae* there is a well developed ovipositor and the eggs are placed in holes cut in the tissues of submerged stems (Endophytic oviposition); in the *Gomphinae* and the *Libellulidae* the ovipositor is absent and the eggs are simply dropped or washed from the tip of the abdomen as it dabs the surface (Exophytic oviposition).

The hemimetabolic life cycle from egg to egg is thus completed. It differs little with the various species except in the period required and the habitat. As to the latter, it may be said that there are no known marine Odonata and but few inhabit even brackish water. The very interesting case of *Mecistogaster modestus* Selys completing its life history in the water collected between the leaf bases of epiphytic bromeliads in Costa Rica and Mexico is described in several papers by Calvert. Most species inhabit lakes, ponds or streams.

Enemies of the Dragon-flies.

Notwithstanding the specialization of the dragon-flies, both nymph and imago, for an exclusively predaceous existence, they are preyed upon by many enemies. Walker and others state that in certain regions there is a great excess of males over females due to the activity of frogs. The females are knocked into the water and devoured while ovipositing in the stems of plants at the surface or while resting upon masses of floating vegetation. As a few species, especially the damselflies, descend beneath the water to deposit the eggs, there is every chance for the success of this enemy. Teneral and newly merged insects are picked up without resistance.

Birds are undoubtedly responsible for the scarcity of many species in the adult state. Walker took *Coryphaeschna ingens* and *Epiaeschna heros* from the stomach of Chuck-will's-widow (*Antrostomus carolinensis*). The Kingbird (*Tyrannus tyrannus*) is several times recorded as feeding upon dragon-flies, and it is quite reasonable to suppose that many of the *Tyrannidae* have this habit. Moore records the capture of so large a species as *Epiaeschna heros* by the Kingbird. Several times in the writer's experience families of Kingbirds have been found perched upon some tree or fence at the pond-side, the young clamoring loudly for the insects taken by the parents. The best

illustration of this was found at a small slough in Cedar County, Iowa, on July 17th, 1908. Four young birds, as large as their parents, were lined up on the uppermost wire of a fence that cut across the margin of the pond at a distance of six or eight feet from the shore. The old birds were busy upon repeated trips to the center of the pond, where they could usually be seen to take *Pachydiplax* and *Sympetrum* on the wing, though they at times half-descended among the tall grasses that formed dense clusters everywhere in the shallow water and arose again immediately with food in their beaks. All of these insects were fed to the noisy young upon the fence. It happened that the wind was blowing from the pond past the birds to the shore, and here, scattered over the pasture land were dozens of dragon-fly wings, which had been clipped off as their possessors were given to the young birds. The species represented were *Pachydiplax longipennis*, *Leucorhinia intacta*, *Sympetrum* sp., *Libellula pulchella*, *Plathemis lydia* and certain *Lestes*.

Years ago the writer remembers having seen numbers of dragon-fly wings about the ponds where swallows were very plentiful, and for several seasons (1907-1909) observations were made beneath a Martin house (*Progne subis subis*) in the yard of a friend. Innumerable Aeshnid and larger Libellulid wings were picked up.

Mr. Geo. J. Miller has described to the writer the capture of *Anax junius* by chipmunks (*Tamias* sp.). While on a canoe cruise down the boundary to International Falls during the summer of 1914, he found the Chipmunks very common and absolutely fearless about camp. And as they perched upon logs or stumps within a few feet of him they were quite likely to be munching away on a big green body of this dragon-fly, the four wings extended to the sides between the grasping paws and the long abdomen hanging, tail-like, beneath. How the insects were captured was not discovered.

Dragon-flies of all sizes have been found caught or enmeshed in spiders' webs. Most of the cases reported do not indicate, however, that the captives had been eaten into by the spiders. Walker gives an account of a single case of a partly eaten specimen of *Aeshna tuberculifera* in the web of *Argiope trifaciata* Forsk. At Lake Madison, near Mankato, the common garden spider (*Miranda aurentia*) was very abundant among the vegetation on the gravel flats, and several instances of enmeshed insects were noted by the writer. Dead but uneaten *Enallagmas* and *Lestes* were not uncommon in the webs and some of them had been there long enough to become dry and hard. One male of *Aeshna interrupta lineata* was come upon, however, while still struggling violently for freedom. The spider ran out to the center

of disturbance several times and succeeded in binding the dragon-fly fast before becoming frightened at the observer and retreating. It was not seen to bite and the insect remained active, until, after waiting some fifteen minutes for further developments, it was removed to the cyanide bottle.

In his "Dragon-flies of the Mississippi Valley" Wilson states that he found *Gomphus spicatus* feeding largely upon damsel-flies, notably *Enallagma* and *Ischnura*. *Gomphus villosipes* was seen catching and eating *Leucorhinia* and *Sympetrum*.

Regarding the nymphs, not so much is known in this particular: Needham shows that a few of the larger species are eaten by the trout and it is more than probable that the damsel-flies are destroyed in great numbers. Many, if not all, species are cannibals. The larvae of the water beetles (*Dytiscidae*, *Hydrophilidae*, etc.) prey upon crayfish, tadpoles and probably on nymphs.

Economic Importance of the Odonata.

It has been the custom to consider the Odonata of no practical importance. These insects have never annoyed man and seemingly have not aided him in combating pests which destroyed his crops or harmed domesticated animals. Dr. J. B. Smith repeatedly affirmed his faith in the neutrality of the group and other workers have quite universally taken the same stand.

It is certainly true that if dragon-flies are influential for better or worse in man's welfare, the part they play is not obvious. However, we cannot but refer to the day, a decade or two ago, when the mosquito, the stable-fly, the house fly and the sand-fly were but annoyances, and though the dragon-fly seems incapable of directly taking a place similar to that of these insect carriers of disease, it may be shown later to be of value in control conditions.

The most frequent suggestion of this kind is that dragon-flies reduce the number of mosquitoes. Applied to the adults the objection is made that mosquitoes are active at night and that the dragon-flies are on the wing during the day only. While this is generally true there are several species of our larger and more numerous dragon-flies (*Aeshna*, etc.) that are very active from sundown until dark, hawking about quite close to the earth and frequenting not only the swamps and open woodlands but even venturing in numbers about the lawns in town and cities. Dr. Walker describes the occurrence of *Neurocordulia yamaskancensis* on Georgian Bay, Ont., and states that no imagos could be found on the wing during the day but that numerous specimens were

seen and taken after sunset on many occasions. It must not be overlooked that the hour of dusk is greeted by rising hordes of mosquitoes and that one of these large dragon-flies possesses an enormous capacity and rapid digestive powers, coupled with unlimited agility. Doane, in his work on "Insects and Disease," does not hesitate to say that dragon-flies "often devour large numbers of mosquitoes during the course of the day and evening."

What applies to the mosquito may be much more true in certain other cases. In searching for the carriers of Pellagra, a disease which is entering Minnesota, it has been suggested that the insect, if it be an insect, must be one that bites during the day and that lives along streams, and every effort is now being made to incriminate *Simulium*. The sand-fly passes its larval stages in the water and the adults remain near the streams; they also bite during the day. It is thus more than probable that these gnats are commonly destroyed by many species of dragon-flies. Again, it passes without question that myriads of flies, including the stable fly and others which follow cattle about the pastures, are captured by these same mosquito hawks. The writer has many times observed Aeshnids darting to and fro about, and even beneath, the cattle along some creek or in the adjoining lowlands.

But a consideration of the adult is less than half the story. The nymphs of the Odonata are doubtless among the most predatory and voracious inhabitants of the waters. Their length of life is from one to four years and countless adults will emerge from a single pond or small stream in a season. They are quite indiscriminate in their choice of diet, only so it be animal, and have been known to eat most of the common aquatic insects and larvae and in addition to occasionally feed upon young fish, tadpoles, crayfish, etc. They are even notoriously cannibalistic.

We may, then, well expect, as is actually stated by some authorities, that Odonate nymphs greatly reduce the number of larvae of various important Diptera, the mosquito especially. The larvae of the midges and "punkies" (*Chironomidae*) have been shown by Needham and others to be very abundant in the habitats of the nymphs and to form a large part of their food supply. In reference to *Simulium*, Professor H. Garman, in his "Preliminary Study of the Kentucky Localities in which Pellagra is Prevalent," 1912, state that "Species of *Progomphus*, *Gomphus*, *Macromia*, *Calopteryx*, etc., were collected among the rocks on which *Simulium* larvae occurred."

Regarding the relation between fish and the nymphs, there is as yet no decision. The work of Professor Needham in New York showed that the food of the brook trout consisted mainly of Chirono-

mid larvae and pupae with but an occasional dragon-fly nymph. In Illinois, Professor Forbes' results on the food of fishes are much the same. Whether or not these nymphs are injurious to the fish in killing some of the young and in using a part of their food supply has not been ascertained.

It is a difficult task to determine the economic status of any animal, and the problem increases in complexity very materially when the more intricate ecological conditions are approached. It is not at all rare to find that those forms least suspected actually possess the greatest influence upon man's welfare. In the case of the Odonata it seems the part of discretion to suspend judgment while awaiting further developments.

Topography and Faunal Areas of Minnesota.

A brief survey of the topography and faunal zones of Minnesota may be helpful in showing the relation of the fauna dealt with in this list, from but a small section of the state, to the whole.

The topography of the state is characteristically glacial; its native rocks, from the Archean to the Cretaceous, are covered throughout all but the extreme eastern points with recent drift of varying thickness. This drift is from 100 to 300 feet thick in the valleys of the Minnesota and the Blue Earth, and thins out gradually to the east and north. Practically no rock is exposed *in situ* within the drift area, except along the larger rivers of the southern and eastern sections. Hundreds of kettle-holes and many larger lakes lie in the drift or upon the underlying rocks, the former condition being common in the south and the latter in the north.

Of the two areas not covered at present with till, that in St. Louis and Cook Counties is far the most extensive, the boundary line running from near the western end of Lake Superior northward to Rainy Lake. The western part of this region possesses scattered patches of drift, always quite thin. The Mesabi and Vermilion Ranges, with an elevation of 2,200 feet, and the mountain-like hills of the Superior region are of Pre-cambrian quartzites and granites, laid bare by ages of scouring by the ice.

The other, and truly driftless area, occupies Houston County and the eastern three-fourths of Winona and one-half of Fillmore Counties in the southeastern corner of the state. It is directly continued into Iowa, covering Allamakee and the eastern half of Winneshiek Counties and follows the Mississippi in a narrow belt. Its topography is wholly erosional. Its rivers, of which the Rock is the largest, run east-

ward to the Mississippi through valleys and entrenched meanders in the Cambrian strata from one to five hundred feet in depth. Its gorges and valleys are wildly picturesque and its general surface is flat or slightly rolling and covered with loess from the great river.

In general, the highlands of the State lie in the central western part. The Leaf Hills of Otter Tail County have an elevation of 1,700 feet and the prairie west of Itasca Lake in Becker County stands some 1,600 feet. From this center arise three drainage systems of varying ages: the waters are carried northwestward by the tributaries of the Red River of the North and the Rainy River; to the southward and eastward by the Mississippi, the Minnesota and the St. Croix, and to the eastward in the northern portion by the smaller streams feeding into Lake Superior. The elevation of the northwest corner of the State is a little more than 750 feet, increasing in the southeast to 900 or 1,000 feet. In the extreme southwestern corner, set off by the Coteau des Prairie, Rock and parts of Pipestone and Nobles Counties have an elevation of 1,800 to 1,900 feet, and drain to the southwest.

Thus the central belt of the State is occupied by a great depression in which lie the valleys of the Red River of the North, the Mississippi, the Minnesota and the western half of the St. Croix, flanked by highlands from 1,800 to 2,200 feet in elevation on the southwest and northeast. This depression marks the ancient outlet of glacial Lake Agassiz.

If we now turn to the life zones, we immediately note their coincidence with the topographic features. The boundary between the Canadian (the lower division of the Boreal Region) and the Transition (the upper division of the Austral Region) Zones enters Minnesota in Pine County on the east, near the head waters of the St. Croix, and passes westward through Mille Lacs to the junction of the Crow Wing River with the Mississippi, hence northwestward between Leech and Itasca Lakes, west of Red Lake and into Ontario to the west of Lake of the Woods. On the south, the boundary line separating the Transition from the Upper Austral (Alleghanian) bisects Houston County from north to south, meanders through the two northern tiers of counties in Iowa and again enters Minnesota in Nobles County and follows the Coteau des Prairie into South Dakota. Thus the northeastern third of the State belongs to the Canadian, a fragment of the southwestern to the Upper Austral and the whole central belt of valley land from northwest to southeast, 800 to 1,200 feet below the highlands, to the Transition Zone.

The region thus covered by the Transition, or Alleghanian Zone includes four topographic types. The areas drained by the Red River and the Minnesota are markedly prairie and constitute the richest farm

lands of the Commonwealth. The valley of the Mississippi, within the State, is more rugged and is occupied by the Big Woods. Here the forests run from wholly coniferous in the north to the ordinary deciduous trees in the south, its lower limit being a little north of Mankato. The third area is made up of the deeply eroded, though glaciated, and densely wooded valleys of the St. Croix and the Mississippi (between Dakota and Wabasha Counties). And the last division, described in an earlier paragraph, is the small driftless area of the southeastern counties.

Preface to the Faunal List.

The faunal list included in this paper relates to but a small part of Minnesota's Transition Zone, that triangle which might be cut off by drawing a line from Nobles County through Hennepin to Washington. The writer's records from that part of Iowa which lies within the zone have also been included: Dickinson, Emmet, Winneshiek and Allamakee Counties. In Minnesota the counties in which collecting has been done are as follows: Blue Earth, Nicollet, Freeborn, Winona, Wabasha, Goodhue, Dakota, Washington, Ramsey and Hennepin. Most of the records along the Mississippi are taken from Wilson's list for the Mississippi Valley. The remainder have been made by the writer, and on account of the latter's location at Mankato, Blue Earth and Nicollet Counties have been more thoroughly worked than the rest. Lake Madison is a small lake some four or five miles in length in the northeastern part of Blue Earth County.

In preparing the catalogue that follows, the species in the collections of the University at St. Anthony Park are not included. Through the kindness of Professor F. L. Washburn the writer was allowed to examine this material but as the specimens bore no locality labels and had been in the Department for some years their origin was not actually known. It is, however, more than probable that they are from the State and most likely from Ramsey and Hennepin Counties. The species in the Lugger collection determined with certainty follow:

Calopteryx maculata.
Ischnura verticalis.
Hagenius brevistylus.
Æshna constricta.
Anax junius.
Celithemis eponina.
Celithemis elisa.
Sympetrum vicinum.

Erythemis simplicicollis.
Pachydiplax longipennis.
Plathemis lydia.
Libellula luctuosa.
Libellula quadrimaculata.
Libellula pulchella.
Libellula incesta.

Of these, but three, *Celithemis elisa*, *Sympetrum vicinum* and *Libellula incesta*, are not listed in the catalogue from definite localities.

It is to be regretted that the limits of this paper preclude a treatment of the nymphs. Those desiring descriptions of the nymphs of Minnesota species must be referred to the papers of Needham, Walker and others.

The plates accompanying the paper are made from photographs taken from life by the writer.

Classification of the Odonata.

This group of insects is made up of forms possessing an aquatic nymphal or larval stage and a winged imago. These states being separated by no marked pupal stage the metamorphosis is Hemi-metabolic. Both nymph and adult have large compound eyes, segmented antennae and mandibulate mouth parts; they are voracious in all stages. The four membranous, netted-veined wings of the adult usually possess a pterostigma on the costal, apical region of each. The antennae and the tarsi are each three segmented. The abdomen is very long and slender, and consists of ten distinct segments, exclusive of an anal segment ending in the dorsal or superior appendages. The males have inferior terminal appendages also, and the opening of the testes is on the ninth and the accessory genital organs are on the second segment. The females are without terminal inferior appendages and have the vulva at the sternal apex of the eighth segment.

Key to the Sub-families.

- A* Slender species with eyes widely separated, thorax weak, wings similar and laid together along the back when resting; nymphs with three caudal gills. (Sub-order *Zygoptera*.) Family *Agrionidae*.
 - a* More than two antecubitals Sub-family *Calopteryginae*
 - b* Two antecubitals only Sub-family *Agriioninae*
- B* Usually larger and heavier bodied, with eyes touching or but slightly separated; thorax large and strong; front and hind wings unlike, the latter widest, and both held horizontally in repose; males with single inferior appendage. Nymphs without caudal gills. (Sub-order *Anisoptera*.)
 - a* Triangle equally distant from arculus in front and hind wings; antecubitals of the two series not corresponding throughout. (Family *Aeshnidae*.)
 - a'* Pterostigma with a brace at its inner end in space below it.
 - a''* Subtriangle of fore wing of single cell.
 - x* Eyes widely separated by occiput Sub-family *Gomphinae*
 - y* Eyes touching for some distance Sub-family *Aeshninae*
 - b''* Subtriangle of fore wing of three cells Sub-family *Petalurinae*
 - b* Pterostigma without a brace vein Sub-family *Cordulegastrinae*
 - b* Triangle of hind wing much nearer arculus than that of front wing; antecubitals of two series practically corresponding. (Family *Libellulidae*.)
 - a'* Triangle of hind wing considerably beyond arculus; more than two cubito-anal cross veins Sub-family *Macromiinae*
 - b'* Triangle of hind wing on a level with arculus or in front of it; one or two cubito-anal cross veins
 - a''* Sectors of arculus distinctly separate at their departure from the arculus; eyes tubercled behind Sub-family *Cordulinae*
 - b''* Sectors of the arculus closely approximated or fused for some distance beyond arculus; eyes not tubercled behind Sub-family *Libellulinae*

SUB-ORDER ZYGOPTERA, THE DAMSEL-FLIES.
FAMILY AGRIONIDAE.
SUB-FAMILY CALOPTERYGINAE.

Genus *Calopteryx* Leach.

C. maculata Beauv. Wilson's records of this widely distributed and usually common species are the only ones thus far for the State: Lake Amelia and Reed's Landing, July 6 and 7, and 18, 1907. It is common to the Transition and Austral Zones and has been taken frequently in Iowa and Wisconsin.

This very conspicuous damsel-fly is to be found along streams, generally the smaller ones, weakly fluttering over the ripples at the water's edge or perching on the vegetation within a foot or two of the surface. Not infrequently numbers of them rest among the taller grasses of the shady flood plains some distance from the water. Though sometimes taken about ponds they are usually much less plentiful there. They are especially fond of small streams overshadowed by willows and wild cucumber vines.

C. acquabilis Say. A few specimens were taken in Wabasha and Hennepin Counties by Wilson. It is common over the greater part of Wisconsin, belonging to the Transition and Upper Austral Zones, and the writer possesses several records of it in northern and northeastern Iowa. Its habits are very similar to those of *C. maculata*.

Genus *Hetaerina* Hagen.

H. americana Fabricius. Though not in the Minnesota collections and lists at the author's disposal, this species is sure to be found native to the State. It is very generally distributed over the Transition and Austral Zones and has been taken by the writer in many counties of Iowa, including Dickinson on the Minnesota border. Muttkowski records its general distribution in Wisconsin.

This beautiful species is often found in company with *H. tricolor* and *C. maculata* along rippling brooks and even larger streams, probably never about ponds or lakes. Like the other members of this sub-family it is a gregarious species, at times occurring by hundreds over small rapids and resting upon protruding rocks or drooping branches of willow. On the wing during July, August and September.

H. tricolor, the nearest relative of *H. americana* may be found in the southern part of the State but not extensively. It has been taken as far north as Cherokee County, Iowa, by the writer and apparently belongs to the Austral Zone.

SUB-FAMILY AGRIONINAE.

Genus *Lestes* Leach.

L. eurinus Say. Will probably be found occasionally over the southern counties of Minnesota. It was taken in June, 1909, on Lake Okoboji in Dickinson County, Iowa, and Muttkowski states that it is found in western Wisconsin.

L. inequalis Walsh. Wilson records two specimens from near St. Paul, and at Red Wing, Goodhue County, "Both sexes common in shady places near the woods."

L. unguiculatus Hagen. This seems to be the commonest *Lestes* in southern Minnesota. At Mankato, and on Lake Madison, Blue Earth County, the author has collected hundreds of specimens during late May, June, July, August and early September. It is an inhabitant of pond and small lake regions and is very seldom seen about streams. Wilson's list does not show a single occurrence along the Mississippi River. It seems clear that great numbers of this species migrate from pond to pond or lake to lake during the breeding period, ovipositing for a day or so at each stopping place. Incomputable myriads of copulating pairs will one day cover the rushes of a swamp, and on the following morning but a few scattered pairs will remain.

L. uncatus Kirby. The only records of this heavy bodied, bright colored *Lestes* are from Mankato, Blue Earth County, and Alden, Freeborn County. Three pairs were collected in the latter locality June 10-15, 1914, by Miss Anna Holgersen. *Uncatus* is often found at considerable distances from water.

L. disjunctus Selys. This species is included as a possible Minnesota form on the strength of collections made by the writer at Spirit Lake, Iowa, in July, 1909. It is never a common species.

L. forcipatus Rambur. *Lestes forcipatus* Rambur was taken at Mankato on July 13 and 20, 1913, and at Lake Madison, August 4-11, 1914. It was fairly abundant during July, though copulation seemed to occur more freely on the later dates. This was also found true in studying the Iowa fauna.

L. rectangularis Say. Two males only of this form were collected at Lake Madison, August 4-9, 1914. Both Wilson and Muttkowski record it for western Wisconsin and the writer has taken it in several Iowa localities. *Lestes rectangularis* frequents lakes, rivers and even woods. It is not common to the Lower Austral.

L. vigilax Selys. "Both sexes found in tall weeds and grass back from the water; not very common." Reed's Landing. Wilson. Also recorded Lake Phalen, Ramsey County. It is a very common species in Wisconsin.

Genus *Argia* Rambur.

A. moesta putrida (Hagen). Wilson took this species along the Mississippi between St. Paul and Hastings, July 12, at Red Wing, July 17, and at Winona, July 19, 1907, including both sexes. It was usually seen in company with others of the same genus. The writer has collected all four species together sunning themselves upon the rocks and sandy banks of the Iowa River. At the approach of the net they seem to dissolve in the sunshine, so rapid are their motions, and at its retreat to again precipitate from the atmosphere upon the gray face of the rock.

A. violacea Hagen. Recorded from Lake Okoboji, Dickinson County, Iowa, and from Wisconsin.

A. tibialis Rambur. Wilson's records are the only ones for this form thus far. Stillwater, July 15, 1907: "Both sexes flying about in open sunshine in company with *L. quadrimaculata* and *Leucorhinia intacta*." Red Wing, July 17, 1907: "Both sexes common along the river bank." Found also in northern Iowa.

A. apicalis Say. This is the only species of *Argia* that has come under the writer's net within our boundaries. Numerous specimens are at hand dated as follows: August 1, 1912, July 20, 1913, and August 14, 1914. Wilson took the species at Hastings, Stillwater and Red Wing, July 12-17, 1907. It is the commonest *Argia* of Minnesota and Iowa.

Genus *Nehalennia* Selys.

N. irene Hagen. Taken very frequently during June and July, 1913, at Mankato. Also at Beaver Lake, St. Paul, on July 10, 1910 (Wilson). It is usually found in the tall grasses about marshy places and kettle-holes, never venturing into the higher air but keeping close to the water along the shore line or fluttering unseen between the stems of the sedges. Common in surrounding states.

Genus *Amphiagrion* Selys.

A. saucium Burm. After two seasons collecting in Blue Earth County without seeing this species, the writer discovered it in small numbers and in teneral condition along a very small stream leading from the "slough" to the Minnesota River at Mankato, on June 11, 1913. A few days after, thousands of fully colored individuals were copulating and ovipositing in the shallow water among the sedges and Sagittarias. A week later their numbers began to reduce and by July 7 but an occasional specimen could be found. During the whole period

their distribution was limited to an area of 200 yards along this little rivulet, so narrow that one could easily leap across it anywhere, and but a few inches deep. Again in 1914 they were common here and nowhere else. Such a localization is not what would be expected of a species distributed from the Atlantic to the West.

Genus *Enallagma* Charpentier.

E. carunculatum Morse. Innumerable specimens were taken at Lake Madison, August 4-11, 1914. Wilson took the species at Lake Phalen, Ramsey County, July 8, 1907.

E. civile Hagen. A few males were found among other *Enallagmas* collected at a pond near Mankato on June 14, 1913, and during October, 1914, several more specimens, male and female, were brought in by students. Three males were netted at Lake Madison, August 8, 1914. *Civile* resembles *carunculatum* in everything except the appendages of the male.

E. hageni Walsh. From the middle of May until September *E. hageni* is the most plentiful and universally distributed *Enallagma* in southern Minnesota. During June it is usually present about ponds in such numbers as to be taken by the netful rather than as individuals. Masses of algae, sphagnum or other floating vegetation are dotted with its bright blue and black.

Wilson has taken it all along the Mississippi River, "hundreds at a sweep of the net."

E. ebrium Hagen. Records at Mankato for males July 6, 1912, June 14, 1913, and July, 1914. Taken by Wilson at Minneapolis, St. Paul, Red Wing, and Winona from July 8-19, 1907. Common; usually in company with *E. hageni*.

E. signatum (Hagen). "Quite common flying about the floating algae." Wilson, St. Paul, July 8, 1907. Taken by the writer at Center Lake, Dickinson County, Iowa, July 13, and at Lake Okoboji, June 29, 1909. A companion of *antennatum* and *hageni*, and *Nehalennia irene* in the marginal grasses.

E. antennatum (Say). "Rare, only a few seen; found on rushes over water." Wilson, Lake Phalen, July 8, 1907. Probably not common in the Transition Zone, though fairly so in the Austral.

Genus *Coenagrion* Hagen.

C. angulatum Walker. Two males of this recently described species* were picked up with a lot of *Enallagma hageni* and *Nehalennia*

* Canadian Entomologist for September, 1912. See also "New Species of Dragon-flies," by Richard A. Muttkowski. Bulletin of Wisconsin Natural History Society, Vol. X, Nos. 3 and 4.

irene at a little kettle-hole at Mankato on June 10, 1913. It flies rather low over the water between grass tufts a foot or two from the shore. Its short heavy body and bright blue and black coloration quickly catches the eye of the collector. In Iowa it was taken with *Coenagrion resolutum* Hagen.

Genus *Ischnura* Charpentier.

I. verticalis Say. Innumerable specimens taken at Mankato from May to September, including both sexes. It was very common at Lake Madison, August 4-11, 1914, and here the orange females predominated. Found at Minneapolis and St. Paul by Wilson, July 6-8, 1907. *Ischnura* is as constantly present as *Enallagma hageni*, though never in great numbers, and in the same habitats.

I. posita (Hagen). "Found in company with *Enallagma hageni* and *E. ebrium* everywhere; not as plentiful as the former but more so than the latter." Wilson, Beaver Lake, St. Paul, July 10, 1907. Also at Winona, July 19.

SUB-ORDER ANISOPTERA, THE DRAGON-FLIES.

FAMILY AESHNIDAE.

SUB-FAMILY GOMPHINAE.

Genus *Hagenius* Selys.

H. brevistylus Selys. A single male specimen of this conspicuous dragon-fly was found by the writer in the collections of the Mankato State Normal School. It bore the label "Mankato" only, without date. Occasional specimens have been collected throughout every faunal zone from the Boreal to the Lower Austral, usually over swift water in large streams. In New York, Needham also found the nymphs plentiful in ponds.

Genus *Gomphus* Leach.

G. fraternus Say. Pair in copulation taken at Mankato, June 11, 1913. Wilson found both sexes common from St. Paul to Red Wing, July 12-17, 1907. It is very often taken in pastures and open woodlands back from the rivers. About rapids they dart swiftly here and there above the turbulent water, dash in and out of the leafy arches along the banks or rest tightly flattened against the boulders in mid-stream. Common to the Transition and Upper Austral Zones.

G. externus Selys. Both sexes taken by Wilson at Red Wing, Minn., and at Lansing, Iowa, July 17-24, 1907.

G. spicatus Hagen. "Three captured, all females." Wilson, Lake Phalen, St. Paul, July 8, 1907.

G. villosipes Selys. Taken in numbers with *G. spicatus* as above.

G. cornutus Tough. On June 7, 1913, this rare and little known species was found transforming at a little kettle-hole near Mankato. A fresh female and a dozen exuviae were picked up from the floating sticks, algae, etc., at this time. On June 10th a male was obtained as it transformed. No mature adults were seen. So far as the writer knows the nymph has never been described.

G. amnicola Walsh. Two males were captured at Mankato, June 21, 1913, and August 14, 1914. One female taken at Red Wing, July 17, 1907. *Amnicola* is very swift upon the wing and often keeps well to the middle of the stream. The nymph is still unknown.

G. vastus Walsh. "Common everywhere; most of the specimens secured were males." Wilson, Red Wing, July 17, 1907. Also taken at Prescott, Wisconsin, and Lansing, Iowa.

G. crassus Hagen. "A single female secured in company with *G. vastus*." Wilson, Red Wing, July 17, 1907.

Genus *Aeshna* Fabricius.

Ae. interrupta lineata Walker. A male of this species was taken at Lake Madison, August 9, 1914, and a female at Mankato, June 19, 1913. Walker states that *Aeshna interrupta lineata* is the most characteristic dragon-fly of the Canadian Zone and that it also ranges as far south as Missouri.

Ae. verticalis Hagen. (*Ae. juncea verticalis* (Hagen), of Wilson's List.) Taken at Lake Phelan, St. Paul, July 8, and at Hastings, July 12, 1907.

Ae. constricta Say. A pair in copulation was captured in an open, pastured woodland along the Minnesota River near Mankato. The insects hung quite motionless from the lower branches of the oaks, allowing the net to approach them without seeming to heed it. Three females were taken along a wooded roadside which skirts Lake Madison, most of them as they clung to the under sides of leaves or twigs, devouring their prey. All of the above females were heterochromatic. This seems to be our commonest species of *Aeshna*.

Genus *Anax* Leach.

A. junius, Drury. Undoubtedly this large dragon-fly is to be found very commonly over the entire state from April to November. Specimens in the writer's collection represent three localities—Alden, Man-

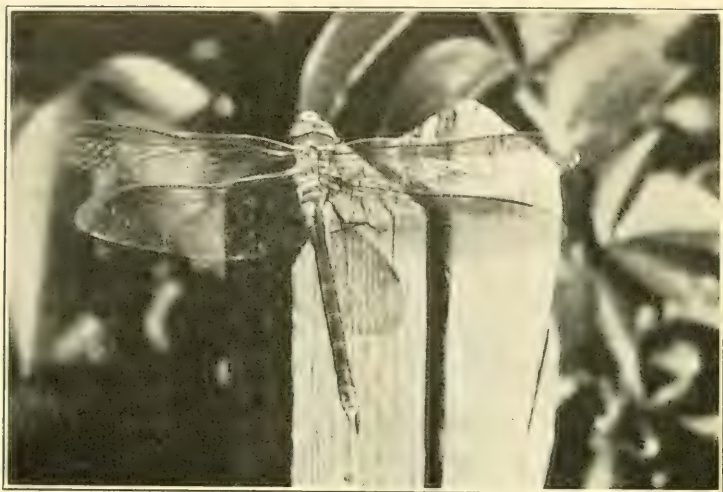


FIG. 14. *Anax junius*, Male. Photo by A. D. Wheden.

kato and Lake Madison—and are too numerous to list separately. Wilson found it common at every stop made along the Mississippi River in July, 1907.

As early as March 5th the writer has observed *Anax junius* ovipositing in the ponds, usually the smaller and more shallow ones, and the worn condition of these females suggests that they had hibernated through the winter. While in copulation the pair flies rapidly about over the pond or settles upon a weed stalk near the ground. When ready to oviposit, they alight upon a floating stem, the male retaining his hold on the female while she plunges her abdomen half its length into the water and begins working its tip upon the submerged stem, the abdomen at first straight and then by degrees arched until the tip almost reaches the thorax. When once well at work she is not easily disturbed and will remain for fifteen or twenty minutes without changing position, although the male at frequent intervals tugs away as though to lift her bodily into the air. Sometimes the female deposits her eggs unattended and Needham states that she may even descend beneath the water for this purpose. Both sexes are constant hunters and may be noted, at dusk especially, hawking about lawns and dwellings and over cornfields or along the margins of the woods.

FAMILY LIBELLULIDAE.

SUB-FAMILY CORDULINAE.

Genus *Epicordulia* Selys.

E. princeps Hagen. Two males of this expert flier were brought down by the net on the shore of Lake Madison, August 10, 1914. It was seen on this one occasion only and but four individuals, three males and one female, were counted. The shore here was covered with tall weeds and bushes, with trees a few yards back and a *Sagittaria* bed in the shallow water in front. *Libellula pulchella* and *Plathemis lydia* were the only other large dragon-flies present. Wilson captured one male at Stillwater, July 16, 1907.

Genus *Tetragoneuria* Hagen.

T. cynosura Say. Wilson's records of this form are from Lake Phalen, St. Paul, and Hastings, July 8 and 12, 1907. He found it common. About the lakes in Dickinson County, Iowa, it was fairly numerous during the latter half of June and the whole of July 1909. *T. cynosura semiaquea* Burm., given specific rank by some writers, was also present.

These insects are extremely quick and tireless on the wing. They often dart back and forth across some glade or small clearing near the shores of the larger lakes, keeping at a height of thirty or forty feet from the ground and at long intervals resting for a moment upon the upper boughs of a tree. When over the water they fly lower but dart with extreme rapidity along the reedy margins of some promontory.

T. spinigera (Selys). Taken at Lake Amelia, Minneapolis, Beaver Lake, St. Paul, Hastings and Stillwater by Wilson, July 6-16, 1907. Quite abundant.

Genus *Dorocordulia* Needham.

D. libera (Selys). "Several seen flying over small streams; hard to catch but both sexes secured." Wilson, Stillwater, July 16, 1907. This beautiful species seems limited to the Transition Zone.

SUB-FAMILY LIBELLULINAE.

Genus *Tramea* Hagen.

T. lacerata Hagen. No specimens of this or other members of the genus have been actually taken within our limits, but the writer has spent hours on several occasions in unsuccessful attempts. From June 10, to July 15, 1913, two or more species of *Tramea* were quite common about the ponds in the sand bars of the flood plain along the Min-

nesota River at Mankato. *Lacerata* could be identified with certainty but the other and lighter colored species could not be recorded without capture. A brief quotation from the writer's note book for June 28 will suggest something of the habits of these swift and wary Libellulids: "The hours from 9-11 were spent at the sand-bars on the river. In the sun the temperature was excessive, probably 100° or over, and the sands seemed alive with tiger-beetles and Hymenoptera. About several small ponds left by the falling river sailed dozens of Libellulas and among them a lesser number of Trameas of at least two species, *lacerata* and another of lighter color. *Plathemis lydia* and *Libellula* unfailingly darted after every *Tramea* that came near, pestering it much as kingbirds will a hawk. I attempted to take advantage of the moments when they were hard pressed but my efforts resulted in nothing but danger of sun-stroke. The ponds are very similar to those where *Pantala* and *Tramea* were so common at Cherokee, Iowa."

In all probability these species are limited to the Austral and southern parts of the Transition Zones.

Genus *Libellula* Linné.

L. luctuosa Burm. Quite common at Lake Madison, August 4-11, 1914, several well colored males and a teneral female being taken. Many more were seen about the docks and boat landings. Along our eastern border Wilson found this species, both males and females, common and usually well matured by July 10-16, 1907.

L. exusta Say. A female was sent in from Alden, Freeborn County, about June 12, 1914, and a male is recorded from Mankato, June 21, 1914. Lake Amelia, Minneapolis, July 6-7, 1907, one male. At Beaver Lake, St. Paul, on July 10, Mr. Wilson writes: "Abundant everywhere, most common with *quadrifasciata* in the undergrowth close to the shore. When it alights it squats like a *Gomphus* on the rocks, stumps, or even on the ground. It is gregarious, as many as fifteen or twenty alighting on the same spot; it is also inquisitive and many were caught that actually alighted inside the net as it was being carried. The males are predominant and all are pruinose thus early."

L. quadrifasciata Linné. Between the 10th and 30th of June, 1914, Miss Holgersen collected 10 males and 5 females in good color at Alden. At Mankato a pair was taken on June 13, 1913. Wilson collected numbers of these insects at St. Paul, Hastings and Stillwater, July 8-16, 1907. At the latter place they were extremely plentiful: "Found by hundreds in the old lumber yard on the bank of the St. Croix; every stick, stub and bush alive with them. They were very

tame, alighting not merely on the net but also on the hand and arm and all over the clothing." The writer has found this species, much less common and far more wary, in northern Iowa.

L. pulchella Drury. The records of this largest and most common *Libellula* are far too numerous to list here. Males and females in all conditions have been taken at Mankato, Alden, Lake Madison, Minneapolis, St. Paul, Hastings, Red Wing and Winona by Wilson, Miss Holgersen and the writer from June to September. It is as much to



FIG. 15. *Libellula pulchella* on mullen stalk in pasture. These dragon flies have been repeatedly observed industriously catching flies which attack stock. Photo by A. D. Wheden.

be expected about every pond and stream as is the usual vegetation. It feeds quite constantly upon Diptera and undoubtedly destroys hosts of small and medium-sized flies. On capturing the prey, the dragon-fly kills it by piercing with its sharp mandibles; it is then rolled rapidly over and over by means of the feet and spiny legs, while the jaws are kept constantly busy clipping and crushing until only a pulpy ball remains. This is rapidly devoured, the time required being from one to two minutes, and the insect is off again after another victim.

Genus *Plathemis* Hagen.

P. lydia Drury. Taken in numbers at Alden, June 10-20, 1914; at Mankato from June 1 to August; Wilson's records cover July 12-20, 1907, at Hastings, Stillwater, Red Wing, Winona and Homer.

This species is a constant companion of *L. pulchella*. Often they have a definite beat along some bend in the shore or around beds of bulrushes where they race up and down the banks, now and then meeting with a rustle of wings. The female of *lydia* very much resembles *L. pulchella*.

Genus *Celithemis* Hagen.

C. epolina Drury. At Lake Madison, August 4-11, 1914, this species was more numerous than any other, except certain damselflies. The lake having fallen several feet in the past few years has in many places about its shores wide gravel flats, grown up to shrubs and tall-stemmed weeds. It was upon these flats that *Celithemis* was most common, in fact, it was seldom seen elsewhere. A few were taken on August 4th along a bay filled with cat-tails, bulrushes and sedges. On the 5th they were present in great numbers on the gravel flats, notwithstanding that the day was very dull and a steady drizzle of cold rain falling. They were covered with glistening rain-drops, which were shaken from their wings as they fluttered from perch to perch.

In bright weather they were much more agile and quite difficult to capture. When in copulation, they would often ascend fifty or sixty feet and dart off over the lake for a time. During windy days, and it was very windy whenever it was bright, they seemed to delight in battling with the gale and in clinging like weather-vanes to the tallest weed-stalks, their wings half set.

Celithemis is distributed over the whole of the Austral and the Transition Zones and other species will likely be taken, especially *elisa*.

Genus *Leucorhinia* Brittinger.

L. intacta Hagen. During June and July *intacta* is to be seen daily about our ponds. In 1913 the first record at Mankato was June 7th, and August 11, 1914, a single female was taken at Lake Madison; the writer possesses dozens of specimens collected between these dates at Mankato. Wilson also took the species all along the Mississippi. They are usually very alert and agile, floating before the collector like a host of jet-black ivory-centered balls. When resting, the wings are thrown forward, the abdomen held high in the air and the head is kept turning watchfully from side to side.

L. proxima Calvert (*Frigida* Hagen). Wilson secured both sexes of this hitherto eastern species at Lake Phalen, St. Paul, July 8, 1907, and other specimens at Beaver Lake, St. Paul, and Hastings on the 10th and 12th.

Genus *Sympetrum* Newman.

S. rubicundulum Say. Probably common over the State from June to September. Seen on every field trip at Mankato during this period and was found breeding in very great numbers in the swamps about Lake Madison during August. Reed's Landing, July 18, 1907; Wilson.

This is our commonest and most universally distributed *Sympetrum*, being seen everywhere from the swamps and streams to the sidewalks of the cities.

S. rubicundulum assimilatulum Uhler. The data for this sub-species is almost identical with that for the above species. It is not quite so plentiful, however.

S. albifrons (Charpentier). "Both sexes were captured in the tall weeds along the edge of the woods; they seemed to prefer shady spots." Wilson, Reed's Landing, July 18, 1907.

S. obtrusum Hagen. Mankato, August 18-20, 1914, 3 males and 1 female. Lake Madison, August 8 and 9, 1914, 2 males. Taken about lakes and ponds.

S. semicinctum Say. Quite common at Mankato from June to August. Usually found among the low shrubs and brush at the margins of woods near streams or ponds, and most plentiful in August or late July.

S. corruptum Hagen. Mankato, June, 1912, male and female; April 27, May 11, June 10, and August 15, 1913, both sexes; April to October, 1914, many specimens. Along the roads and railroads and in the open woods this large *Sympetrum* is very common at all seasons but is most plentiful perhaps in August and September. It is one of the first dragon-flies to appear in the spring, having been repeatedly taken or photographed in April.

Genus *Perithemis* Hagen.

P. domitia Drury. The only record of this little species is from Lake Madison, August 4-10, 1914. It is, however, of very general distribution and may be expected over most or all of the State. It is common in northern Iowa. On Lake Madison it was present in great numbers about the beds of yellow water lilies and *Potamogeton* in the quieter bays, now flitting over and now resting upon the lily pads and never far above the surface.

Genus *Erythemis* Hagen.

E. simplicicollis Say. This cosmopolite is recorded at Mankato, Lake Madison, Lake Phalen (St. Paul) and Stillwater. It is common, though not very abundant, wherever found, from June to September. During July and August many of the individuals taken are old enough to be wholly pruinose, obscuring their original bright green coloration. One usually meets with it along the shores of lakes and ponds where it perches upon weed stems or flattens itself against a path, a dock or an old boat. Its voracious appetite keeps it continually active.

Genus *Pachydiplax* Brauer.

P. longipennis Burm. Taken at Mankato, June 13, 1913, and at Alden two males and three females, June 10-30, 1914. In habit and actions *P. longipennis* is very much like *Leucorhinia intacta*, with which it quite constantly associates. It is recorded from many localities in Iowa and Wisconsin.

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Pasture land bordering a stream favorable to the breeding of *Culicoides* and *Hebertella*. These dragon flies prey upon insects annoying stock. Photo by Whedon.



Female *Anax junius* accompanied by male, ovipositing upon floating cat-tail stem.
Photo by Whedon.



Celithemis eponina, male and female. Photo by Whedon.



Pasture land about Lake Madison, Minn.; favorite habitat of *Celithemis eponina*.
Photo by Whedon.



Indian Lake, a typical Odonata pond. Note pasture land in background, frequented
by various species. Photo by Whedon.



Libellula pulchella, male. Photo by Whedon.



Plathemis lydia, female. Photo by Whedon.

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THE ACRIDIIDAE OF MINNESOTA

BY M. P. SOMES

INTRODUCTION

The material upon which this paper is based includes, in large part, the collections of insects accumulated during the seasons of 1911 and 1912, while the writer was engaged in economic work against the destructive locusts of Minnesota. In addition many facts are included which were drawn from a study of the collections of the Division of Entomology of the Minnesota Agricultural Experiment Station and from collections made by the writer in Iowa and Minnesota at other times.

The aim of this paper has been to place before students interested in the Orthoptera the facts which have been gained to date concerning the most important family of the order, together with field notes, life histories, ranges, and generic and specific descriptions and keys which may facilitate accurate and definite identifications. In every instance a definite Minnesota record for each species has been included, if possible. Every effort has been made to furnish data which shall apply to the forms found in this State, and the tables and descriptions have been rewritten and modified to fit them to local conditions instead of including details which may apply only in areas widely separated from Minnesota.

No glossary is included since no new terms have been used and all here included are fully covered in numerous glossaries and dictionaries readily accessible.

This bulletin was prepared at the suggestion of Professor F. L. Washburn, Chief of the Division of Entomology of the Minnesota Agricultural Experiment Station, and to him thanks are due for the attention given to the preparation of the illustrations, colored plates, and figures in text, all of which are new, and for numerous other courtesies. Our thanks are also extended to D. Stoner, M. C. Tanquary, J. Zetek, C. W. Howard, and others who were associated with us in the economic work. Quotations have been taken from some of their notes but in every such case full credit has been given. Without such helpful coöperation in collecting and field observations the data here presented must have been much less complete. To Professor L. Bruner, of the University of Nebraska, and A. N. Caudell, of the

Smithsonian Institution, who have aided with kindly advice and criticism as well as in the verification of certain species, we extend our grateful thanks for these and previous favors. To the many friends in Minnesota who have contributed in various ways to make our work not only possible but also pleasant, we desire here to express our fullest appreciation. Among those of conspicuous service to us, both in this and in our economic work, were the county officials of Norman County, who furnished us with excellent laboratory facilities at Ada; the school board of Fergus Falls, Superintendent R. B. MacLean, and J. E. Metzger, who aided us in various ways and generously gave the use of their high-school building for office and laboratory purposes; and Wright Brothers, also of Fergus Falls, who gave us enthusiastic coöperation and gratuitously furnished tracts of land for our field experiments. Acknowledgments are also due to Miss I. L. Wood, artist of the Division, for her work in making drawings.

ACRIDIIDAE

The Acridiidae constitute that family of the saltatorial Orthoptera in which the antennae are shorter than the body, the tarsi three-jointed, the ocelli three, and the ovipositor short and never ensiform. It thus includes the group commonly called the "short-horned" grasshoppers and among this group will be found almost all of the species which are of serious economic importance, at least within our area. The subfamilies may be separated by the following characters:

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|---|--------------------|
| Tarsal claws without an ariolum; pronotum dorsally prolonged over the abdomen; tegmina lobiform; insects of small size | <i>Tettiginae</i> |
| Tarsal claws with an ariolum; dorsum of pronotum never extended over more than the basal segments of abdomen; tegmina various; insects of various sizes | |
| Prosternum not armed with a distinct conical or cylindrical spine, though sometimes supplied with a low blunt tubercle | |
| Face more or less oblique, usually meeting the vertex at an acute angle; foveolae usually well developed; wings (in our species) never marked with contrasting colors | <i>Tryxalinae</i> |
| Face vertical or nearly so and rounded at meeting with vertex; foveolae usually obscure; wings usually marked with contrasting colors, though pale yellowish in some, and clear in <i>Camnula</i> | <i>Oedipodinae</i> |
| Prosternum armed with a distinct conical or cylindrical spine | <i>Acridinae</i> |

SUBFAMILY TETTIGINAE

The first subfamily, *Tettiginae*, is made up of small, obscurely colored insects found, for the most part, in low open places upon either mud or sand. Their colors, blending well with the background, render them very inconspicuous and they are commonly passed unnoticed, save by collectors who know their habitat. We have but two

groups of this subfamily represented in Minnesota and these may be separated as follows:

Anterior femora more or less compressed, carinate above; antennae with 12 to 14 joints	<i>Tettigiae</i>
Anterior femora distinctly and broadly sulcate above; antennae with 16 to 22 joints	<i>Batrachideae</i>

TETTIGIAE

The *Tettigiae* are represented within our borders by three genera which may be distinguished by the following characters:

Median carina of pronotum cristiform; antennae with 12 (rarely 13) joints	<i>Nomotettix</i>
Median carina of pronotum low; antennae with 14 (or less) joints	<i>Tettix</i>
Vertex advanced beyond the eyes and wider than one of them; generally angulate anteriorly	<i>Tettix</i>
Vertex not advanced beyond the eyes; generally truncate anteriorly; body broad between the shoulders	<i>Paratettix</i>

NOMOTETTIX Morse

Body scabrous, granulate, or rugose; vertex of head extending beyond the eyes and wider than one of them, its front angulate or rounded but not truncate. Pronotum with its median carina raised and cristiform, more or less arched longitudinally, the front margin produced in an angle projecting over the back of the head. Superior sinus on posterior margin of lateral lobes of the pronotum shallow, being only about one half as deep as the lower. Between the posterior portion of the eyes and the median carina of the pronotum, a pair of nipple-like tubercles are usually present. The antennae are normally short and filiform with 12 or rarely 13 joints. In this genus the abbreviate form with the pronotum extending only to the tip of the abdomen, is most common, although occasionally the long or extended form is taken. The genus is represented in the United States by a very few species, nearly all of which are rare and local. We have but one species which is unknown outside our limits.

Nomotettix parvus Morse

Nomotettix parvus is an interesting little insect which is readily distinguished from the members of the following genera by the arched and cristiform pronotum and by the considerably smaller size of the individuals. In general appearance it has much the aspect of immature *Tettix*. There is much variation in coloration, the general tint of the body varying from gray or brown to nearly black, while forms occur

in which the dorsum is unmarked, although commonly there are four dark spots arranged on the disk of the pronotum and occasionally a light-colored mid-dorsal line. This species was first noted by us at Cass Lake, July 24, 1912, when it was abundant in both adult and immature forms. It was most plentiful in a spot evidently flooded at times but not marshy. At that time it was simply moist soil covered with a turf of *Trifolium repens* among which were scattered plants of *Polygonum*, *Mentha*, and *Parnassia*. The insect was noted feeding on *Trifolium* and apparently also on algae, as Hancock has described under *Tettix*. It moves by short, low hops, not at all like the vigorous and surprisingly powerful hop of *Tettix*. The species has been taken at Pipestone, St. Anthony Park, Mahtomedi, Cass Lake, Bena, and Tower.

TETRIX Charp.

Tettix includes insects of relatively small size with the body more or less rugulose granulate. The vertex, when viewed from above, is wider than one of the eyes and, viewed laterally, more or less sinuate; the anterior border angulate, subconvex, or subtruncate; viewed laterally more or less produced before the eyes. Antennae stout, not reaching to the shoulders, and made up of from 12 to 14 joints. The dorsum of the pronotum may be subcompressed, flattened, tectiform, subconvex, or slightly depressed. Pronotum truncate or but slightly subangulate anteriorly; posteriorly more or less attenuate and acute, the apical process sometimes abbreviate. Femora entire or with margins more or less undulate; posterior tibiae slightly enlarged apically; carinae serrulate, short, and spinose. The first joint of the posterior tarsi distinctly longer than the third; pulvilli flat below or subspiculate.

Most of the species of this interesting group occur in two forms, those of the common or extended form and those in which the pronotum is more or less abbreviated. These, while evidently mere forms, have been given varietal names as shown in the table. The insects are all small and of obscure coloration, though in some forms there is a well-marked color pattern. The colors, however, are so variable as to be of no value in separation of species.

Median carina of pronotum distinctly elevated, percurrent; the dorsum more or less tectiform

Body slender; pronotal process posteriorly attenuate

Vertex, viewed from above, obtuse angulate; frontal costa, viewed in profile, slightly sinuate

Pronotum and wings abbreviate

Var. *granulatus*

Vertex, viewed from above, convex; frontal costa, viewed in profile, not at all sinuate

Var. *luggeri*

Body more robust; pronotal process and wings shorter

Median carina of pronotum distinctly percurrent, slightly elevated anteriorly;

- body rather slender
 Pronotum and wings abbreviate Var. *ornatus*
 Median carina arcuate, compresso-elevate; body more robust; middle femora of male nearly half as broad as long Var. *triangularis*
 Pronotum and wings abbreviate Var. *abbreviatus*
 Median carina of pronotum not at all, or but slightly, elevated; in profile barely undulate or anteriorly gibbose; dorsum not tectiform but flattened or sub-concave Var. *hancocki*
 Frontal costa distinctly sinuate; vertex slightly depressed anteriorly; eyes not prominent; body moderately robust Var. *obscurus*

Tettix granulatus Kirby

Tettix granulatus is a rather slender species with the eyes only moderately prominent, the vertex distinctly angulate, and the median carina very slightly advanced. The dorsum of the pronotum and the legs are finely granulated, the dorsum of the pronotum being usually more or less rugose. In this species, as in others of the group, the coloration is variable, running through varying shades of gray and brown to forms nearly black. The disk of the pronotum is often marked with blackish spots and at times bears a median light-colored line. The species is dimorphic, a form being found occasionally in which the pronotum and wings are much shorter than normal. Hancock has designated this abbreviate form as variety *variegatus*.

The species is found throughout the eastern and northern portions of North America. Within our limits we have taken it at Worthington, Redwood Falls, St. Anthony Park, Fergus Falls, Detroit, Crookston, Warroad, Hibbing, Tower, and Duluth. Like others of this subfamily it commonly hibernates and has been found even in midwinter in the borings of beetles or other sheltered places.

We have found this insect active even during midwinter, in prolonged warm weather. While normally a shore-loving form, it is sometimes found far from lakes and streams. We once noted a colony of this species in a sandy field in Iowa at least a mile from any stream or body of water. In this instance it was in a cultivated field and feeding upon the tender stems of young grain, where by use of a "sweep-net" we took many specimens.

Tettix luggeri Hancock

Tettix luggeri is very closely related to *T. granulatus*, from which it may be distinguished by the characters given in the key. Separation is possible, however, only in typical forms and since intermediate forms occur, especially in specimens taken near our northern limits, it is very difficult to separate the two positively. We have taken it at Warroad, Cass Lake, and Allen Junction, in what we consider the typical form, basing identification on a specimen in the collection of

this Division, collected by Lugger. In forms intermediate between this species and *T. granulatus* we have taken it at Detroit, Mahtomedi, and Crookston. Because of the close similarity of the two species as mentioned above and the constant occurrence of intermediate forms it might be more logical to consider these as not specifically distinct but rather as extremes of a variant species.

Tettix ornatus Say.

In *Tettix ornatus* the eyes are prominent and the anterior margin of the vertex is rounded, with the median carina strongly projecting. It is more robust than in the preceding species, with the pronotum less prolonged and with the median carina less elevated, though distinct; coloration is variable, though normally grayish, with the dorsum marked with four velvety blackish spots. Like *T. granulatus* it is found in two forms and to the short or abbreviated form, once known as *T. triangularis* Scudd., the varietal name *triangularis* is sometimes applied. This species is less confined to banks and shores than the preceding species and is at times found far out in woodlands or in fact almost anywhere on sandy soils. In early spring and late fall it may be observed in numbers on sunny exposures, such as rocks or even the cement walks of cities, evidently enjoying the warmth of the sun's rays. We have taken this species at Worthington, Redwood Falls, Pipestone, Mankato, Ortonville, St. Anthony Park, Mahtomedi, Fergus Falls, Crookston, Warroad, Bemidji, Cass Lake, Hibbing, Tower, Mesaba, Duluth, and Hinckley. It is known to occur throughout eastern North America.

In connection with this species we must note *T. acadicus* Scudd., which is closely related to it and most readily distinguished from it because the median carina of the vertex is more prominent anteriorly and the body is shorter. Since this species was described by Scudder from specimens taken at Lake of the Woods, doubtless at or near Warroad, and has also been recorded by Lugger from St. Anthony Park, it is almost certain that it is included in the series listed above, but we were unable to distinguish among them any which could be positively referred to this species.

Tettix hancocki Morse

Tettix hancocki is closely related to *T. ornatus*, from which it may be distinguished by the more robust form and more strongly elevated pronotal carina and the more enlarged posterior femora. In surface granulation and color it is very similar to *T. ornatus* and does not differ

in habitat from that species. We have not as yet taken this species in the northern part of the State but only at Worthington, Redwood Falls, and Fergus Falls. Lügger has recorded it from St. Anthony Falls.

Tettix obscurus Hancock

Tettix obscurus is a slender form, very similar in general appearance to *T. granulatus* but has the dorsum of the pronotum flattened and the median carina very slightly or not at all elevated. It is also very similar to the more southern species, *T. arenosus* Burm., from which it may be distinguished by the more robust form and the less prominent eyes. In habitat it is found in dry open places, varying from sandy banks of streams to the open prairies of the Red River Valley. It has been taken at St. Anthony Park, Redwood Falls, Fergus Falls, and Warroad, and will doubtless be found throughout the State.

PARATETTIX Bol.

Body granulate, scabrous, or rugose; vertex horizontal, narrower, as wide as one of the eyes, or slightly wider, very slightly narrowed anteriorly; the front margin truncate and not produced beyond the eyes; frontal costa between the antennae more or less declined and rarely subsinuate toward the base; the eyes noticeably prominent and subglobose; antennae made up of 14 joints; pronotum rather flattened above and with its anterior margin truncate; posteriorly attenuate, surpassing the tips of posterior femora, although sometimes abbreviated; median carina low; tegmina oval or elongate, the wings usually well developed; hind tibiae with apical third gradually and considerably enlarged; pulvilli of posterior tarsi spiculate. This genus is represented in North America by several species, all save one of which are found only in the South or West.

Paratettix cucullatus Morse

Paratettix cucullatus appears to be especially fond of muddy banks along streams and lakes, and in such places may sometimes be found in great numbers. Hancock has written of its habits as follows: "The muddy shores of the Skunk River, in Iowa, afford a favorable habitat for water-loving and semi-aquatic insects. Along this river, seven miles from What Cheer, the writer found that the Tettigids were unusually abundant June 29, 1894, the species mostly represented being *P. cucullatus*. Swarms, many of which were in sexual union, were frightened up from the immediate margin of the water while the

author made excursions along the shore. A diversity of color existed among this species; many were so colored as to look exactly like the wet varicolored soil. Some had rich russet-red over the whole upper surface of the body or the visible portions of the individuals were entirely clay-colored, or a part of the pronotum only was colored in this manner, while still others were almost coal-black above. These varieties, to say nothing of many more not mentioned, were in perfect harmony with the environment. On careful inspection it was interesting to observe with what accuracy these colors agreed with the tinges of reds, yellows, browns, and grayish blacks existing here and there as patches in the soil. The extreme caution of these insects made it difficult to capture them, and, as they use their wings perfectly in flight, this added to the difficulty of taking the species. Keeping close to the water's edge, the author drove them along with an open umbrella until coming to a little projection of land upon which a large number had congregated. Finally upon a sudden rush at the insects, they flew up in hundreds, to find that return to land was impossible; they fell back into the water. It was only necessary now to gather the little swimmers in as they made exquisite use of their dilated, paddle-like, hind tibiae in seeking the shore. The aquatic powers of this insect are more perfect than those of any other of our local species."

The following notes made by the writer while in Iowa may be added: Fort Dodge, Iowa, July 12, 1910.—*P. cucullatus* was very abundant along the muddy banks of a small stream. Mating was in evidence and many pairs were *in coitu*. There appears to be every possible shade of dark coloration among the individuals. The males are mainly of two distinct color types: one rather uniformly light-colored or grayish and the other very dark-colored with the ventral parts and cheeks chalky, giving much the appearance of *Tettigidea lateralis*. The grayish males appear to predominate.

This insect has been taken at nearly all places in Minnesota where collecting has been done and will doubtless be found throughout the State wherever muddy banks offer favorable habitation.

BATRACHIDEAE

Among the *Batrachideae* the body is rugulose or scabrous; the front is vertical or slightly oblique; vertex generally large and truncate anteriorly; frontal costa always sulcate from base to median ocellus; usually narrow though sometimes widely separated; antennae are rather long and usually of from 16 to 22 joints, the first joint being much larger than the others and the second joint globular and small;

pronotum always more or less tectiform, advanced anteriorly above the occiput, the front margin rounded, obtuse-angulate or terminating in a small cusp, which is directed forward between the eyes; the posterior process of the pronotum is acute and variable in length; the elytra are more or less rounded apically and normally marked with a small light spot near the tip; posterior tibiae are enlarged toward the tip; the carinae multispinose; first joint of posterior tibiae scarcely longer than, and often only equal to, the last. We have only one genus represented in our fauna.

TETTIGIDEA Scudd.

Vertex distinctly wider than, or at least equal to, one of the eyes in width, the anterior lateral carinae terminating obliquely or rounded, middle carinae more or less elevated. Frontal costa compressed and advanced before the eyes and coalescent above with the median carina of the vertex. Antennae relatively short and made up of 22 joints. The dorsum of the pronotum is scabrous, finely granulate, and usually more or less rugose; its sides sloping downward between the shoulders, the posterior portion flattened and attenuate or abbreviate; the anterior margin more or less projecting forward upon the head and, in our species, rounded or obtuse-angulate. We have but one species, although, as is common in this subfamily, it is found in two forms.

Tettigidea parvipennis Morse

Body moderately robust; vertex about twice the width of one of the eyes (very distinctly so in the male) and projecting before the eyes; from the crown there projects a small lobule upon each side covering a portion of the upper, inner border of each eye; dorsum of pronotum distinctly tectiform anteriorly and flattened posteriorly, where it is normally extended and attenuate. This insect is, within our limits, commonly found in the long-winged or extended form, to which the varietal name *pennata* is sometimes applied. It appears to be common throughout the State, though rather scarcer in the northern part. In spring and fall it often congregates in great numbers and we have taken it in great numbers by "sweeping" through sandy fields of young grain in spring. During the winter it hibernates under various covers. The short-winged or typical form is found associated with the long-winged but is commonly much less abundant. Rather peculiarly, with us, the short-winged form appears much darker in tint than its relative and often bears very distinct and striking whitish markings on dorsum, cheeks, and femora.

SUBFAMILY TRYXALINAE

The subfamily *Tryxalinae* is exceedingly closely related to the *Oedipodinae* and the differentiation of these two is sometimes an extremely difficult matter. While it is true that in general the forms are readily placed, yet on the other hand there are forms in which the characteristics of the two subfamilies are so intermingled that separation becomes a matter of arbitrary rule. The characteristic forms of *Tryxalinae* have an oblique front with the vertex horizontal or even slightly ascending, but in the *Oedipodinae* also forms are found having similar characters. There are a few characters which may be relied upon to differentiate these subfamilies, at least so far as our species are concerned. In the *Tryxalinae* the carina of the pronotum is never crested, or cut by more than one sulcus save in *Mecostethus*, while in the *Oedipodinae* the carina may be cut by one, two, or no sulci and is often crested. In the *Tryxalinae* we have no forms with colored wings, while in the *Oedipodinae* practically all of our species have at least the basal part of the wings distinctly colored.

The insects of the *Tryxalinae* have in general slender bodies, often with elongate, cone-shaped heads much suggesting the *Conocephalinae* among the Locustids. Long- and short-winged forms of species are common and the coloration is also extremely variable, there being often distinctly green and brown forms with all the intermediate tints. The subfamily in general frequents tall grasses, and such plant formations as the *Carices* offer the most common habitat, although some species are more commonly found amid the scattered vegetation of sandy areas. Usually the posterior legs, while long, are very slender and the insects in general have much poorer leaping powers than those of related groups, all appearing to depend more upon flight as a means of escape from danger. The coloration is such, in many forms, as to render the insects almost invisible when feeding and these species appear in large measure to rely upon this protective coloration. While, as has been suggested, flight is the common means of escape, in many forms the wing area is too small to aid greatly in this and even in those forms with well-developed wings the flight is rather feeble and in most cases not well sustained.

More than thirty genera belonging to this subfamily are known in North America and of these less than a dozen are represented in Minnesota. Several of our species are extremely rare and we have but one species, *Stenobothrus curtipennis*, which becomes abundant enough to be of economic importance. The following key will serve to distinguish the genera of this subfamily as represented in our State :

Mesosternal lobes separated by a space almost linear in narrowest part; metasternal lobes almost approximate in both sexes *Mermeria*¹

Mesosternal lobes separated by a space never much longer than broad, generally broader than long; metasternal lobes rarely approximate

Antennae triquetrous, acuminate, and strongly flattened at base *Opeia*

Antennae never triquetrous, not acuminate or distinctly flattened at base, usually filiform, though sometimes clavate

Tempora foveolate or plain, not visible from above; face decidedly oblique

Scutellum of vertex with a distinct median carina, usually stronger anteriorly

Antennae depressed apically, somewhat clavate; supplementary carinae accompany the median on head or pronotum or both *Eritettix*

Antennae not depressed or clavate but long and filiform; no supplementary carinae on head or pronotum *Chloealtis*

Scutellum of vertex with no median carina

Median carina of pronotum cut much behind the middle; lateral carinae of pronotum parallel; foveolae of vertex wanting *Dicromorpha*

Median carina of pronotum cut at or near the middle; lateral carinae of pronotum more or less arcuate; foveolae of vertex evident *Orphulella*

Tempora foveolate or plain, visible from above; face less oblique to nearly vertical

Intercalary veins of tegmina strongly developed; median carina of pronotum high and sharp, cut plainly before the middle, or very rarely at the middle, by the principal sulcus *Mecostethus*

Intercalary veins of tegmina not strongly developed; median carina of pronotum not high or sharp

Inner apical spines of posterior tibiae subequal in length

Antennae filiform *Stenobothrus*

Antennae clavate *Gomphocerus*

Inner apical spines of posterior tibiae very unequal, the inferior about twice as long as superior; median carina of pronotum not cut by principal sulcus *Ageneotettix*

OPEIA McNeill

The vertex nearly horizontal, shorter than the distance between the eyes, convex and a little sulcate behind the lateral carinae which are prominent and meet at an angle of about ninety degrees. Median carina distinct. Lateral foveolae are small sulci, not visible from above, extending from the ocellus toward the vertex; frontal costa sulcate, except at apex. Viewed laterally the face is nearly straight and strongly declivent. The antennae are decidedly flattened, especially toward the base, regularly acuminate, and shorter than the head and pronotum. The pronotum has the disk nearly flat though somewhat tectate upon the prozona. The median and lateral carinae are very strong and cut by the principal sulcus considerably behind the middle. The lateral carinae are nearly parallel upon the prozona but diverge somewhat posteriorly from the principal sulcus to the posterior margin of the pronotum which is subangulate. The lateral lobes of the pronotum are not quite so high as long and are in large part perpendicular although slightly convex above; they bear, below the middle, a nearly

¹*Mermeria* is included above for the ready identification of *M. bivitatta* Serv. which, although not yet taken in Minnesota, has been taken by us in Iowa near the border of Minnesota and may be expected within our area.

horizontal carina extending from the principal sulcus to the posterior margin; their anterior and posterior borders are oblique and their lower margin nearly straight. Prosternal tubercle absent. Tegmina usually shorter than the abdomen in the female although in a specimen now before us they extend considerably beyond the tip of the abdomen. This genus is represented in North America by but one species.

Opeia obscura Thom.

Opeia obscura is, in general, western in distribution but we have taken it at Brown Valley, Fergus Falls, and Mankato. It is extremely variable, particularly in coloration. In typical forms the dorsum is green or brown and nearly plain, although sometimes more or less distinctly streaked with fuscous along the median carina. The sides are marked by a stripe extending backward from the eye, largely dark upon the head but widening and becoming more obscure posteriorly. This stripe consists, upon the pronotum, of five parts as follows: An upper streak of brownish or fuscous below the lateral carina; below this a somewhat broader light or greenish streak, followed by a white line on the prozonal lobe, which is continued as a white, raised, nearly horizontal carina across the metazonal lobe; below this a dark streak similar to the upper one and this followed below by another light or whitish streak. Bruner, speaking of this species, says "it occurs where the grasses are short and the climate arid," but in all cases where it has yet been taken in this State, it has been found in damp or marshy places amid tall grasses and *Carices*. The following measurements are from a female, taken at Fergus Falls: length 19.5 mm., tegmina 14.5 mm., and hind femur 11.5 mm.

ERITETRIX Bruner

Head more or less conical, occiput not elevated, furnished with three carinae, one median and two supplementary. The median carina extends from the pronotum to the tip of vertex where it becomes enlarged, the supplementary from the pronotum to a point opposite the anterior margin of the eye where they are each abruptly deflected to join the lateral carinae of the vertex, thus marking off the vertex into an equilateral triangle. Foveolae are shallow and triangular, not visible from above. Frontal costa has the sides regularly divergent from the vertex to the clypeus, generally a little constricted above the ocellus and slightly sulcate for a greater or less distance above this but never sulcate to the vertex. The antennae are thick, generally somewhat flattened at the base, and clavate at the apex, which is bluntly

acuminate, and are scarcely longer than the head and pronotum. The pronotum has the lateral and median carinae distinct and cut only once, decidedly behind the middle, by the principal sulcus. Besides the three usual carinae there are two supplementary carinae, one on either side of the median and lower, or obsolescent, at the principal sulcus. The posterior margin of the pronotum is very obtusely angulate. The lobes of the pronotum are about as high as long, with the anterior border decidedly more oblique than the posterior. They bear a more or less distinct carina, which runs obliquely downward from the first sulcus to or near the posterior margin. The anterior lower angle is obtuse while the posterior is nearly rectangular. The lower margin is straight and nearly horizontal on the posterior half and slightly ascending on the anterior half. The mesosternal lobes are separated by a space much wider than long and the metasternal lobes by a space longer than wide in both sexes. The wings are usually well developed in both sexes. There is no intercalary vein and the dividing vein is soon united with the plicate vein. The ovipositor of the female is nearly included. The posterior femora are stouter than is usual in this group, with the tip extending more or less beyond the end of the abdomen; they are not marked with cross bands but the colors are sometimes arranged in longitudinal bands. Posterior tibiae are usually obscurely colored in yellowish or clay but never blue; the inner apical spur is about twice as long as the outer. The genus includes small, variously colored, active insects which may be readily distinguished by the supplementary carinae and the oblique carina upon the lobes of the pronotum. But one species has, as yet, been taken within our area.

Eritettix tricarinatus Thom.

Eritettix tricarinatus occurs, with us, in two distinct color forms, most commonly of a brownish tone with the dorsum and tegmina marked with black spots, but sometimes of a bright green general color, similarly marked. It has been noted as rather common in early spring on high gravelly hills in Ottertail County. We have taken it there as early as May 1, and it is numerous until near the middle of July. Hibernation carries it through the winter in the immature stages and mating and oviposition occur in early summer. As with most related forms, the males are much smaller than the females but similar in general appearance. It is a very alert and active little insect and the pale color, small size, and active habits make it a very hard subject for close observation in the field. The green form somewhat resembles *Orphulella speciosa* Scudd. in the field, although the clubbed antennae and the supplementary carinae readily distinguish it from that species.

While the association may be purely accidental, we have always taken this species in the vicinity of the low wild sage, *Artemisia*.

CHLOEALTIS Harr.

Vertex triangular and slightly declivent, not extending before the eyes as much as the distance between the eyes, convex, sulcate to a greater or less degree, the lateral carinae a little elevated and the median carina weak but never entirely wanting. Lateral foveolae absent. Frontal costa more or less rounded above the ocellus, plain, or but slightly sulcate below with the sides subparallel. The antennae are decidedly flattened at the base and much longer than the head and pronotum, in the male being as long as the posterior femora. Face nearly straight when viewed laterally. The disk of the pronotum nearly plane with the three carinae, equally distinct, and cut much behind the middle by the principal sulcus; the lateral carinae curved in both sexes, more strongly so in the female. Posterior margin of the metazona is straight or gently curved but not angulate. The lateral lobes of the pronotum are longer than high with anterior and posterior margins straight, strongly and about equally oblique; the inferior margins straight and nearly horizontal or slightly descending posteriorly and more decidedly so anteriorly. Mesosternal lobes separated by a space much broader than long and the metasternal, by a space broader than long in females and about as broad as long in males. Tegmina generally abortive in females and well developed, though rather short, in males. The scapular area is strongly expanded, especially in males. Posterior femora are moderately slender, more or less banded above. Inner apical spurs of the posterior tibiae are about equal in length. Two species of this genus have been noted in Minnesota and these may be separated as follows:

- | | |
|---|--------------------|
| Posterior margin of disk of pronotum straight; lateral lobes of pronotum black in males | <i>conspersa</i> |
| Posterior margin of disk of pronotum obtusely rounded; lateral lobes of pronotum not black in males; larger species | <i>abdominalis</i> |

Chloealtis conspersa Harr.

Chloealtis conspersa is a small and rather inconspicuous, although brightly colored, species in which the sexes differ markedly in coloration. The males are brown, beautifully mottled with fine black spots and with the lateral lobes of the pronotum shining black. The color of the ventral surface of the body is a rich reddish brown. The wings and tegmina are well developed and notably expanded at the scapular

area (see Plate I, 3). The females are considerably larger, of duller coloration, without the black lobes on the pronotum, and have short and abortive tegmina and wings. There is a truly remarkable likeness in color and form of the females of this species to those of the brownish forms of *Dicromorpha viridis* Scudd., but they may be separated by the fact that in *Chlocaltis* there is a distinct median carina on the vertex and the lateral carinae of the pronotum are not parallel.

In Iowa this species is confined to woodlands or their immediate borders, but in Minnesota, where it is very generally distributed, it may be found even far out on the treeless tracts of the Red River

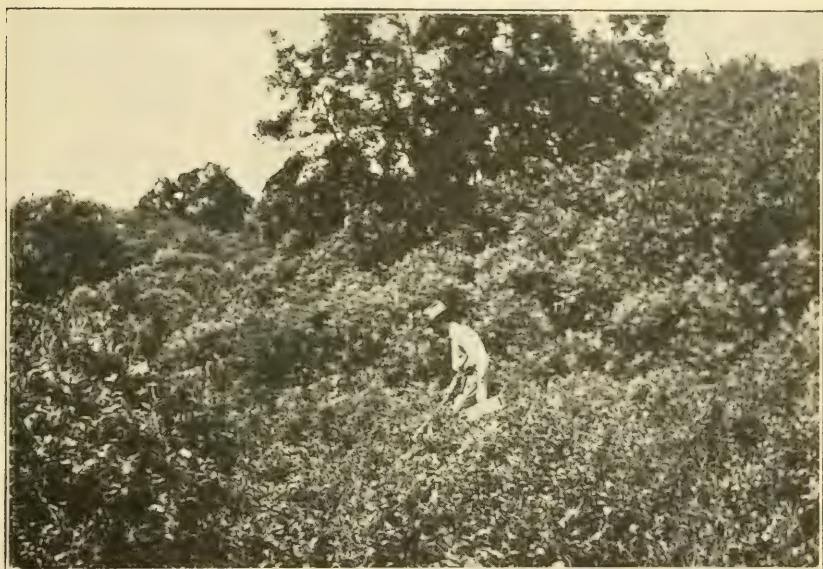


Fig. 2. Normal Habitat of *Chlocaltis conspersa*

Valley. Its common mode of oviposition is by drilling holes in wood and there depositing the eggs and mucous, but on the open prairies of Minnesota it must adapt itself to different conditions and possibly oviposit even in the soil, as we have taken it in many places where there were no trees or even fence posts, yet the species was more plentiful than in the woodlands of Iowa. The following from our field notes, taken in Iowa, may be of interest here.

July 26, 1909. We noted a female *C. conspersa* drilling in a discarded fence rail of birch which was lying on the ground. She tried one spot after another and after a few minutes wandered aimlessly upon the log making tentative examinations of the surface at intervals, but finally came back almost to the spot she had left and there began

work again. After working busily for nearly half an hour, she withdrew the abdomen and walking down the side of the log climbed upon a stalk of *Carex* and spent some time nibbling there, until an incautious movement alarmed her, when she dropped to the ground below. We lay perfectly quiet, hoping she would return and perfect the drilling in the log, but after a time she began to edge cautiously away evidently seeking to escape. We caught her, placed her in a box, took her home, arranged a cage, and supplied a number of pieces of wood, hoping to see the process of drilling repeated. Although she fed freely we were apparently unable to select satisfactory pieces of wood as she rejected all and died within a few days. Dissection showed 19 well-matured eggs in the body.

From the insectary notes of C. W. Howard, taken during the summer of 1912, we take the following regarding this species: "My specimens oviposited in fallen branches of oak, about $1\frac{1}{2}$ or 2 inches in diameter, usually in quite firm, sound pieces. The female bores a hole in the wood, either straight down from a broken end, following the grain of the wood or at a wide angle with the surface of the wood. About 10 eggs are laid in each pod although as few as 4 are sometimes deposited. The pod is about 10 mm. broad and 20 mm. long, from 4 to 7 mm. of which is occupied by the dark brown varnish which cements the top, bulging up in the center with a convex surface. The eggs are about 5 mm. long by 1 mm. thick and are creamy white in color, slightly narrowed at the cap end."

Although doubtless state-wide in distribution, the following will give definite locality records of places where we have found this interesting little insect: Pipestone, Redwood Falls, Granite Falls, Campbell, Fergus Falls, Crookston, Bemidji, St. Cloud, Tower, Duluth, Hinckley, Mahtomedi, St. Anthony Park, Invergrove, Northfield, Mankato, and Sauk Center.

Chloealtis abdominalis Thom.

Specimens of *Chloealtis abdominalis* were taken in July, 1912, in a dense brush of *Ceanothus*, *Salix*, and *Taxus*, near Bemidji, in land now partly cleared but formerly covered with a growth of piniferous forest. Even at first glance, its rather more elongate form, slightly different coloration, and the brown lobes of the pronotum assured us that it was not *C. conspersa*. But one adult male was taken, although careful search disclosed several immature forms but no more adults. This locality is doubtless near the eastern extreme of the range of this species which has heretofore been taken in Montana and North Dakota.

DICHROMORPHA Morse

Vertex much shorter than broad, somewhat declivent, convex but more or less sulcate behind the distinctly elevated lateral carinae. These are straight or gently curved and meet at an angle, usually exceeding ninety degrees. The median carina is entirely wanting as are the lateral foveolae. The frontal costa is sulcate above and below the ocellus with the sides gently divergent downward and more or less constricted just below the ocellus and at the vertex. The face viewed laterally is nearly straight. The antennae are a little longer in the male but scarcely as long in the female as the head and pronotum. The disk of the pronotum is plain with the three carinae nearly straight and parallel, all cut distinctly behind the middle by the very faintly marked principal sulcus. The first and second sulci are not visible on the disk. The lateral lobes of the pronotum are perpendicular, longer than high, with the anterior and posterior margins strongly oblique, the latter plainly sinuate with the lower margin a little descending posteriorly, more strongly ascending and sinuate anteriorly. Lobes of the mesosternum are separated by a space broader than long in the female or as broad as long in the male; lobes of metasternum separated by a space as long as broad in the female or contiguous in the male. Tegmina are generally abortive, though rarely well developed; but in such cases the scapular area is not noticeably expanded. Posterior femora are stout and not banded; posterior tibiae are obscurely colored with the inner apical spurs very unequal. But one species, which is common throughout North America, is found here.

Dichromorpha viridis Scudd.

Dichromorpha viridis is dimorphic in both coloration and length of wings. The long-winged form (*Chyrsochraon punctulatum* Thom.) is rare but has been noted at Worthington. The short-winged form is very common and most of the males are green in color while the females are more commonly of grayish or brownish tints. It has appeared in the field that there may be some element of sexual attraction attached to this diversity of coloration, since in numerous pairs observed *in coitu* the great majority were of oppositely colored individuals. The species is commonly found in damp, shaded places, such as the rich vegetation of lowlands and low woodlands. It has been taken at Worthington, Pipestone, Amboy, Mankato, Redwood Falls, Monticello, and Fort Snelling. It has not been noted as yet north of the Minnesota Valley.

ORPHULELLA Giglio-Tos.

The Orphulellas include insects of small or medium size, slender, and vary, in our forms; from green to brown, sometimes variegated with pink or purple. Vertex nearly horizontal and not extending before the eyes a distance greater than its own width; median carina obsolescent, sometimes very faintly indicated in part; the lateral foveolae usually present though small and not visible from above. The antennae are filiform, medium in length, sometimes depressed or acuminate. Pronotum with median carina distinct and usually of moderate strength, cut at or behind the middle by one sulcus; lateral carinae, in ours, more or less divergent before and behind the sulcus, which is very weak; front margin of disk truncate or rarely slightly cuspidate; posterior margin broadly rounded or subangulate. Posterior femora moderately slender, exceeding the abdomen in both sexes; tegmina reaching or exceeding the tip of posterior femora.

So far as now known we have but two species within our State, but as more general collecting is done, it appears very possible that others may be found. Our species may be separated by the following characters:

Lateral carinae of the pronotum strongly incurved; prozona and metazona about equal in length	
Lateral carinae of the pronotum slightly incurved; prozona considerably longer than the metazona	<i>pelidna</i> <i>speciosa</i>

Orphulella pelidna Burm.

Orphulella pelidna is rather small and quite variable in coloration. It has been found at many widely scattered points throughout the State but usually not in very large numbers at any one point. The brown form, with the tegmina and posterior femora somewhat lighter, is the predominant type but in certain localities distinctly green forms may be taken. In this species, as in many of the *Tryxalinae*, most of the green specimens are males. We have taken this species usually amid low vegetation and in areas of moderately moist soil. In the vicinity of Fergus Falls it matures about the middle of July. We have collected this species at Winona, Gray Cloud Island, Mankato, Redwood Falls, Detroit, Fergus Falls, Wadena, Ada, Crookston, and Mahtomedi.

Orphulella speciosa Scudd.

In *Orphulella speciosa* the green form is predominant in both sexes, the vertex and pronotum are somewhat broader than in *O. pelidna*, and the posterior femora generally somewhat stouter with

the tibiae lighter in color. This insect matures somewhat earlier than its congener and, at Fergus Falls, adults are usually taken by about July 10. In the immature instars and frequently in freshly moulted adults the dorsum of the pronotum is pink, yellow, or even purple. A rather dark-colored female is shown on Plate I, 1.

MINNESOTA

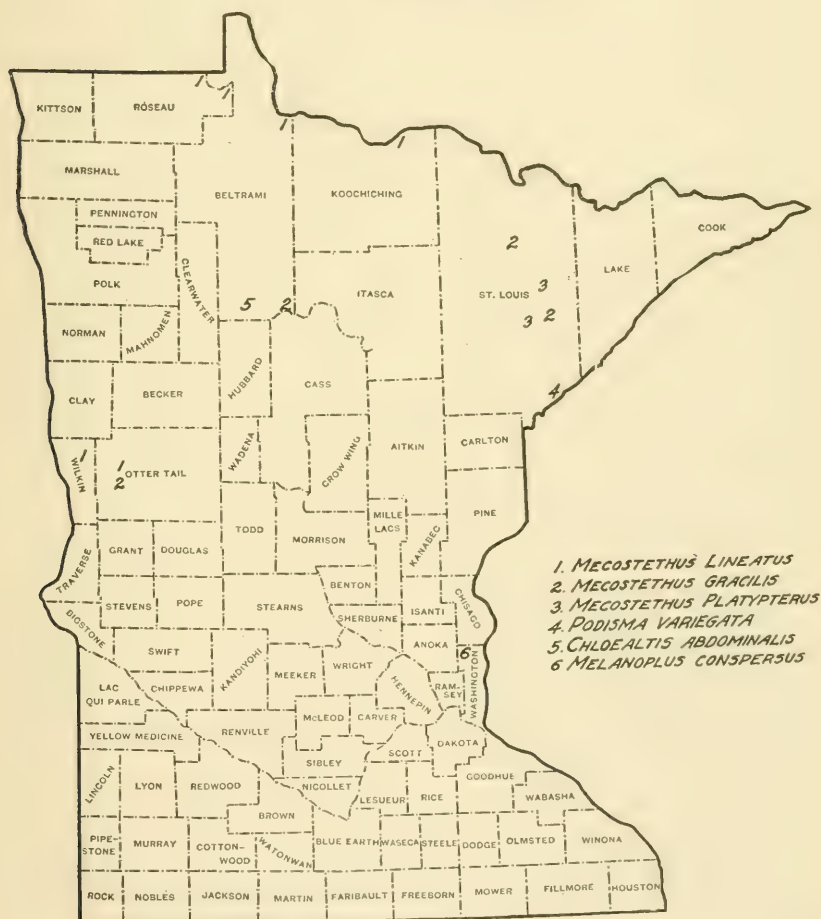


Fig. 3. Records of Some Rare Species

Like the preceding species it delights in areas of low vegetation, although this species is not so closely confined to lowlands, being found even amid the somewhat scattered vegetation of high hills. It doubtless occurs through most parts of the State and we have the following records of captures: Albert Lea, Mankato, Mahtomedi, St. Cloud,

Fergus Falls, Detroit, Ada, Crookston, Pipestone, Redwood Falls, Lake of the Woods, Bemidji, Biwabik, and Vermillion Lake.

MECOSTETHUS Fieb.

Insects of large or medium size, slender, and more or less compressed, for the most part brownish or yellowish in coloration and very local in habitat. The vertex is horizontal, sometimes slightly declivent, produced anteriorly to the eyes for a distance considerably greater than the width of one of the eyes; disk of vertex rather broadly triangular and acute or obtuse at apex; median carina distinct, stronger anteriorly; lateral carinae rather strong; lateral foveolae minute, shallow, and widely separated, visible from above, though sometimes almost obsolete. The antennae are as long as the head and pronotum together in the female and much longer in the male. They are filiform though sometimes somewhat depressed basally. The disk of the pronotum is plane with all the carinae distinct, the median cut at or in advance of the middle. The lateral carinae are also cut at or before the middle, usually by two sulci. The anterior margin of the pronotum is truncate or very broadly angulate, the posterior margin very obtusely angulate. The tegmina are well developed in both sexes, the posterior femora long and moderately slender. The subgenital of the male is acutely produced and nearly horizontal.

Our species may be separated as follows:

Prozona shorter than the metazona; lateral carinae strongly sulcate and divergent from the first sulcus to the posterior margin

Scapular area of the tegmina with a pale streak; intercalary vein of male with very obscure low teeth *lineatus*

Scapular area of tegmina without a pale streak; intercalary vein of male with sharp, elevated, minute, closely set teeth *gracilis*

Prozona not shorter than the metazona; lateral carinae nearly straight and very gently divergent *platypterus*

Mecostethus lineatus Scudd.

Mecostethus lineatus is a very rare insect and has been reported from but few localities, ranging from New England to northern Indiana, Illinois, and Iowa. It is an unusually trim and attractive locust, rather large in size and, while its general coloration is rather somber, the touches of coral-red tend to make it a very handsome insect. The general color is a rather dark brown but a narrow yellowish line extends from behind the eye to, and sometimes more or less distinctly along, the lateral carinae of the pronotum. This line is bordered below by a rather broad dark streak. In most specimens there are also one or two oblique, anteriorly descending, yellow lines on the face and

prozona. The scapular area of the tegmina is inturned, forming a plane dorsally, and is in large part pale or yellowish. Hind femora with the outer face brown of varying tones, the lower sulcus coral-red; the inner face with a longitudinal dark bar in both the superior and inferior fields, sometimes nearly the whole inner face more or less suffused with coral-red; hind tibiae rather pale yellowish with a dark annulation at the base, a somewhat fainter submedian band and apically another dark ring, indistinctly bounded above.

During the season of 1911 we noted one specimen in a marsh near Fergus Falls, but in July, 1912, in low areas near Lake of the Woods, it was found in very considerable numbers and in almost every instar of its development. It was most numerous in the edge of poplar "islands" where the swamps were somewhat drier than in the open. The males especially are very active and not readily taken. Blatchley (The Orthoptera of Indiana, p. 250) says of this species, "The males appear to far outnumber the females, and are much more wild and active, taking flight when a person is a dozen yards distant. They use the wings only in escaping, flying swiftly and noiselessly for 50 to 100 feet and alighting on the stems of tall grasses and sedges among which they make their homes. The only way in which I have been able to effect their capture was by running after them and swooping them with the net as they rose or before they had time to arrange their legs for the upward impetus at the beginning of a new flight." All of this applies exactly in the swamps of Minnesota and it was a matter of considerable hard work to take them in the tangle of wiry plants where they are found. The females are much heavier and more clumsy than the males and apparently rely largely on concealment for escape from danger as they were only taken by sweeping the sedges. The young are uniformly much darker than the adults, some being nearly black, and save for the peculiarly trim pronotum do not suggest the species. When not alarmed, the insects of this species are very similar in habits to the *Locustidae* and especially to *Conocephalus*, climbing slowly up and down the stems of tall sedges and swinging around to hide behind the stems at the slightest motion of the observer. The very elongate head and slender legs tend to emphasize the resemblance.

Mecostethus gracilis Scudd.

Mecostethus gracilis is an especially attractive insect, its trim, neat lines and pleasing coloration serving to distinguish it from its congeners. It can be readily separated from the preceding by the characters given in the key, and especially by the absence of a pale streak along the scapular area of the tegmina. All of our captures of this

insect were accidental in sweeping, and in every case it has been taken from *Carices*. We have taken it at Fergus Falls, Lake Winnibigoshish, Allen Junction, and near the upper end of Vermillion Lake.

Mecostethus platypterus Scudd.

Mecostethus platypterus is about the size of *M. lineatus*, but with the wings relatively shorter. The coloration is of a dull brown with the dorsal field of the tegmina grayish and with no pale stripe along the scapular area. The figure gives a good idea as to the general appearance of this insect, although the relative length of the prozona is apparently exaggerated. The drawing, however, is accurate and correct and the suture passes but little behind the middle. We have taken this insect only in the dense tangles of tamarack swamps near Mesaba and at Allen Junction. At these places the immature stages were not at all rare on July 25, but there were relatively few adults. The species has been reported outside the New England States but rarely; Hart (Bull. Ill. State Lab. Nat. Hist., VII, p. 205) mentioned it from Illinois, and there is a specimen taken at Little Rock, Iowa, in the collections of Iowa State College at Ames.

STENOBOTHRUS Fisch.

Stenobothrus, as now recognized, is largely western in distribution and is made up of insects of small size and varying coloration. The vertex is broadly triangular in both sexes, more obtuse anteriorly in the females. The foveolae are narrow rectangular or almost linear depressions, rather deep, and plainly visible from above; median carina wanting or sometimes indicated by a lighter line; face quite oblique though rounded at the vertex; head somewhat elevated above the plane of the pronotum. Pronotum rather short, the anterior margin truncate, the posterior broadly subangulate in males, sometimes almost rounded in females; the median carina is distinct and cut somewhat behind the middle by but one sulcus; the lateral carinae are, in all our forms, somewhat incurved before the middle. The tegmina are fully developed although varying or dimorphic in length. The posterior femora are somewhat mottled but rarely distinctly spotted; posterior tibiae testaceous or, rarely, red. As now known we have but one species within our limits.

Stenobothrus curtipennis Harr.

Stenobothrus curtipennis is a small insect, which in Minnesota is

generally yellowish (Plate I, 6) in coloration. It was found at every point where collections were made and we are inclined to believe it generally distributed over our whole State. It may be noted in almost any habitat although it appears to be most at home in low moist areas. In early June the nymphs appear in and about such low grounds and these are doubtless its favorite breeding places, but later in summer it spreads out over all adjacent tracts and is one of the species that must be regarded as serious pests in Minnesota. In the extreme northern part of the State, at Lake of the Woods and elsewhere, we found certain variations of color that we did not note at any other points. In these the coloration was a dull brown tint, very similar to that of most of our *Melanopli*, while among them were forms more or less, occasionally quite distinctly, reddish, which had a striking resemblance in the field to some species of *Melanoplus*. In other places we have noted the cheeks and sides of pronotum, together with more or less of the ventral portions of the body a distinctly green color, more or less variegated with brown. In fact an extended study of the variations of this insect would offer a very interesting problem. The flight of this little insect like that of most of the *Tryxalinae* is short and not particularly strong but the males are very active and have truly remarkable leaping powers.

The following, from Mr. Howard's insectary notes is of interest here: "May 27, 1912. Pod of eggs found near Foxhome; hatched May 30. July 8 adults appeared in field near Fergus Falls. Egg pods laid in cages were normal as compared with those dug up in the field. Three examined August 9 were from three-quarters of an inch to an inch long, and somewhat keg-shaped with the opening to the surface of soil tapering and slightly curved and contained five, six, and seven eggs respectively, placed on end in a vertical position in the keg-shaped basal part of the pod. Above them the tube was filled with a pinkish frothy mass. Eggs are of a brick-red color, with the surface roughened. This color makes them easy to distinguish from other species in the field."

GOMPHOCERUS Thunb.

Gomphocerus includes a number of small insects of varied coloration, the structural characters almost exactly as in *Stenobothrus*, save that the antennae are clavate, having a short depressed club at the apex. According to Bruner the tympanum is partly open. While but one species has been noted in our collecting, the following key will serve to distinguish the only two species likely to be found in our State.

Anterior tibiae clavate, with a distinct groove on outer face; size of males about 14 mm. in length *clavatus*
 Anterior tibiae only moderately and regularly expanded apically in the males, which are about 18 mm. in length *clepsydra*

Gomphocerus clepsydra Scudd.

All of the material that we have seen or collected from Minnesota appears to belong to *Gomphocerus clepsydra*, taking McNeill's Revision of the Tryxalinae as a basis for classification. The anterior tibiae are not noticeably clavate and bear on the outer face no trace of such a groove as that mentioned for *G. clavatus*. The size of the males is subject to too much variation to be of real value, since we have before us specimens ranging from 11.5 to 21 mm., yet identical in all structures and in some cases taken together. In 1911 a brood of this species reared in cages from the egg, gave two males measuring 13 mm. and 19 mm. respectively. The coloration is widely variable and ranges from green to neutral grayish and through all intermediate shades to distinctly brown forms. This color variation is, however, much more common among the females than among the males, which are in general a rather light brown. The length of tegmina and wings is also subject to great variation, especially among the females, where it is often very short, while in the males it usually reaches or surpasses the tip of the abdomen. This interesting little species has been taken in the western part of the State at many points, always in open places, but ranging from the dry soil of gravelly hills to the lowlands and open flats of the Red River Valley proper. It matures early in July and is especially abundant in August and early September. We have taken it at Crookston, Ada, Fergus Falls, Redwood Falls, Morton, Pipestone, Worthington, Detroit, and Glenwood.

AGENEOTETTIX McNeill

The genus *Ageneotettix* is made up of small insects very similar in general aspect to the *Oedipodinae*; the vertex somewhat declivent, broader than the frontal costa at the clypeus; median carina wanting and the lateral carinae slight; lateral foveolae subquadrate, about twice as long as wide, plainly visible from above; face moderately oblique and more or less arcuate; antennae filiform and exceeding the length of the head and pronotum in both sexes. Median carina of pronotum quite distinct and cut once behind the middle by the principal sulcus; lateral carinae are strongly sinuate and the posterior margin of the metazona is rounded. The lateral lobes of the pronotum are higher than long and the anterior and posterior margins nearly straight and

vertical. The mesosternal lobes are separated by a space several times as wide as long in both sexes; the metasternal lobes are separated by a space a little longer than wide in male and female. The tegmina and wings are well developed, not quite equaling or somewhat longer than the abdomen. The posterior femora have three, usually well-marked, subtriangular or irregular brown spots on the upper face. The posterior tibiae are red or yellowish with the apical spurs on the inner side much elongated and very unequal. We have but one species in this genus.

Ageneotettix scudderi Bruner

Ageneotettix scudderi is a beautiful little insect which has been noted at a number of places but which, owing to its habit of dropping to the ground when alarmed, is commonly overlooked. Blatchley (The Orthoptera of Indiana, p. 249) has said that "when disturbed it leaps vigorously and without noise for several times, then settling down upon a sandy spot will allow a close approach." This is true when it is found, as is often the case, among low or scanty vegetation, but we have noted that when in tall or close grasses it will simply dive headlong to the ground and crouch there among the stems. Certain forms of this species have a very distinct light-colored median line on the dorsum as has been noted in *Arphia* and *Tettix*. We have taken adult specimens of this species at Fergus Falls as early as July 12. It has been taken at Fergus Falls, Granite Falls, Mankato, Northfield, Albert Lea, Mahtomedi, Glyndon, Detroit, and Ada, and will doubtless be found in open places through most parts of the State, save possibly in the extreme north.

SUBFAMILY OEDIPODINAE

The insects of the subfamily *Oedipodinae* have the prosternum unarmed, the face nearly vertical, and the head rounded at the vertex. The fastigium of the vertex always slopes strongly downward, the foveolae are usually present but obscure; the antennae filiform, never strongly modified, though the basal joints or one edge may be somewhat modified in some genera. The eyes are less elongate than in the *Tryxalinae*, being generally shorter than the infraocular portion of the genae. Dorsum of the pronotum usually considerably widened posteriorly; the lateral carinae either indistinct or wanting; the median carina usually strong or cristiform and cut by one or more sulci, except in *Arphia*; the whole dorsal field of the pronotum generally more or less rugose or tuberculate. The tegmina are always well developed

and the wings are nearly always, at least in part, brightly colored. This group includes all of those species of our fauna in which the basal portion of the wings is brightly colored, the colors ranging from yellow to red or in some cases even black, while in certain forms found outside our area they are even blue. So strongly marked is the coloration that members of some species are as conspicuous in flight as the butterflies. The purpose of this coloration has been of considerable interest among students and several theories have been advanced to explain its significance. Morse has said that "it is in no sense protective" and his suggestion is that the colors are probably "of value in the mating of the sexes" but this, while possible, is rather vague.

Without attempting to enter into a full discussion of this subject here, we may call attention to the close similarity in the details of the common Oedipodine coloration to that of the *Catocalae* among moths. In both cases the body color is of some obscure brown or gray, the tegmina similarly obscure, and the wings strongly marked, consisting of a brightly colored field broken by one or more dark bars, contrasting strongly with the field. The coloration is visible, in both cases, only when the insect is in flight and the insects are commonly found upon a background having more or less close resemblance to the obscure colors of the body and tegmina. Two ideas present themselves as worthy of note, though not necessarily as the only explanations possible for the problem. The one is that conspicuous objects, such as these insects are when in flight, may become very much less apparent when the insect suddenly drops upon a suitable background. The strongly contrasting colors being suddenly covered by the obscurely colored tegmina causes the insect to "fade away" in bewildering fashion. We are here considering this coloration, however, solely from the view-point of human optics and can not be certain that the effect upon the eyes of a pursuing bird would be the same. Another thought that has been put forth already by some as a theory explanatory of this coloration scheme, is that the brightly colored area of the wing being so conspicuous will lead a pursuing bird to strike at this non-vital part rather than at the body of the insect. We may here note that we have on numerous occasions seen the English sparrow rise and strike at specimens of *Dissosteira carolina* in flight but pass the same insect without notice while it fed upon the ground. Further, after watching these attempts at capture, we have noted that the bird, in this case at least, does attempt to seize the wing. As to the value of this coloration in mating, it is noteworthy that the coloration is dimorphic in a number of these species and mating occurs, for instance in *Hippiscus rugosus*, between individuals with the wings red or yellow alike. Further, the shades of red or yellow are often identical in dif-

ferent species and even in different genera. An interesting point in connection with this dimorphism of coloration is the fact that while in the *Tryxalinae* it is the front pair of wings that are subject to varying coloration, among the *Oedipodinae* this variation is confined to the second pair.

In most of the members of this group the males, and in some cases the females as well, have the power of "aerial stridulation" by rubbing the bases of the tegmina and wings together during flight and this is under control of the insect. True stridulation, produced by rubbing the posterior femora against the rough edge of the tegmina, is also common here. The members of this subfamily average considerably larger than those of the *Tryxalinae* and the insects are in general much more active and vigorous both in flight and leaping power, some of the species being among the most active and alert of the whole order.

Economically, the members of this group are generally of little importance with us, although two, *Dissosteira carolina* and *Camnula pellucida*, are sometimes capable of doing great damage to crops. Two tribes of this subfamily are found in the Central States and may be distinguished as follows:

Outer margin of hind tibiae with no apical spine next the spurs	<i>Oedipodini</i>
Outer margin of hind tibiae with an apical spine next the spurs	<i>Eremobini</i>

The second tribe is represented by a very large and clumsy species *Brachystola magna* Gir. which, while found in Nebraska and Iowa, has not yet been taken in Minnesota. The *Oedipodini*, however, are well represented in our State and may be separated by the following key:

Interspace between metasternal foramina linear, or longer than broad, in males and narrower than mesosternal interspace even in females

Median carina of pronotum high and arcuate, not cut or but faintly cut by the principal sulcus; tegmina subcoriaceous, the apical portion irregularly reticulate; wings bright red, orange, or yellow, the ulnar area not dilated

Arphia

Median carina of pronotum not arcuate, cut by the principal sulcus; tegmina membranaceous throughout the apical half or at least in the discoidal field; wings nebulous yellowish or fuscous; the ulnar area dilated

Pronotum with the disk tectate and the anterior dorsal margin angulate; hind femora without dusky bars on outer face

Chortophaga

Pronotum with the disk flat and the anterior dorsal margin truncate; hind femora with dusky cross bars on outer face

Encoptolophus

Interspace between metasternal foramina rather broad; in the male quadrate, in the female transverse

Lateral canthi of metazona crossing the principal sulcus and not intersected by it; principal sulcus obsolete or delicate in the lateral lobes

Smaller forms; dorsum of pronotum not rugose or tuberculate; wings sub-vitreous

Camnula

Larger forms; dorsum of pronotum rugose or tuberculate; wings red, orange, or yellow with a dark contrasting area

Hippiscus

Lateral canthi of metazona usually intersected by the principal sulcus; often obsolescent before it; principal sulcus well developed on the lateral lobes

Carina of pronotum entire or cut by but one transverse sulcus

Wings blackish, with a light-colored marginal area	<i>Dissosteira</i>
Wings yellowish with a fuscous, arcuate median band	<i>Spharagemon</i>
Carina of pronotum cut by two transverse sulci	
Inferior margin of lateral lobes of pronotum oblique; posterior angle acute or produced	
Lateral canthi of metazona terminating at the principal sulcus or else there diverted; tegmina maculate with two large squarish fuscous areas	<i>Mestobregma</i>
Lateral canthi of metazona passing and not diverted by principal sulcus; proximal half of tegmina coriaceous; antennae long and basally flattened	<i>Psinidia</i>
Inferior margin of lateral lobes of pronotum horizontal posteriorly; anteriorly oblique; posterior angle rounded or rectangulate	
Radiate veins of anal field of wing normal; hind tibiae unicolorous or but slightly paler basally	<i>Trimerotropis</i>
Radiate veins of anal field of wing distinctly incrassate; hind tibiae with dusky or blackish bands	<i>Circotettix</i>

ARPHIA Stal.

Our species of *Arphia* are all insects of rather more than medium size with the body more or less compressed and of dull brown, fuscous, or sometimes luteous coloration. The vertex is horizontal, subtriangular, triangular, or sometimes nearly pentagonal, the disk having a distinct curved transverse impression behind the middle; the median carina extends back from this impression and the lateral carinae are distinct and well marked; foveolae are rather large, shallow, triangular, or rhomboidal. The antennae are rather long, being about the length of the head and pronotum together. The pronotum has the disk heavily granulate or rugose, the anterior margin broadly and obtusely angulate, the posterior margin also obtusely angulate. The pronotum is narrowed at the principal sulcus and considerably widened posterior to this; prozona very short; median carina very strong and cristiform, very faintly or not distinctly notched by the principal sulcus; the lateral carinae rounded, visible only on the metazona; lateral lobes of the pronotum deeper than long, anterior margin somewhat sinuate, posterior margin somewhat oblique, nearly straight though somewhat sinuate just below the humeri, and the lower corner rounded. Tegmina ample, coriaceous, densely and irregularly reticulate; wings bright red or yellow through most of the field, with a dark curved bar extending from the costal margin to a point near the anal angle, which it does not meet. Near the costa there is, in most species, a more or less well-marked ray projecting toward the base of the wing, and the tip of the wing is usually clear or slightly clouded. Hind femora rather stout, the basal half compressed and dilated, strongly carinate above; hind tibiae are variable in coloration and often somewhat annulate. Our species are all of very similar general appearance and of nearly uniform size. Certain of the species are extremely closely related

structurally and others are dimorphic, thus making the genus one of considerable confusion in separation of species. The following key, which is modified from Bruner's more general key (*Biologia Cent. Americana*) will serve as a basis for specific separation:

Frontal costa with subparallel sides, not sulcate or carinate, broadly truncate at vertex or continuous with the scutellum of vertex; median carina of pronotum variable

Median carina of pronotum cristate and more or less arched

Lateral foveolae of vertex elongate triangular; carina of pronotum high and strongly arched *carinata*

Lateral foveolae of vertex four-sided; carina of pronotum lower and less arched *xanthoptera*

Median carina of pronotum nearly straight, not cristate or strongly arched; wings deep red with curved band very broad and very dark *pseudonietana*

Frontal costa narrowed above to half or less than half the width below the ocellus, sulcate and sometimes carinate above; median carina of pronotum generally straight and not greatly elevated

Frontal costa truncate at apex; wing band incomplete, not attaining the costal margin

Body unusually deep at thorax; pronotum rather long, finely rugose; median carina moderately elevated and gently arched; hind femora robust; disk of wing usually vermillion *conspersa*

Body more slender; pronotum shorter, the rugae coarser; median carina less elevated and hind femora less robust; disk of wing usually yellow *arcta*

Frontal costa convergent above, acuminate at vertex; foveolae of vertex broader than long *sulphurea*

Arphia carinata Scudd.

Arphia carinata is very similar to the following species but may be separated by the characters given in the key. It is dimorphic in coloration of the wings, being found in forms varying from deep yellow to orange red. The coloration of the body and tegmina is also extremely variable, forms occurring of every shade from rich glossy black to reddish tan. The species does not occur until rather late and is not abundant until July. It prefers dry open places, such as the edges of fields and along railway embankments and is often very abundant on sandy bars along streams. It has a very strong flight and, when it endeavors to escape, its flight usually describes an irregular semicircle made up of numerous zigzags, the insect invariably alighting with the head toward the pursuer. During flight it stridulates freely, especially at the angles or zigzags, though when suddenly startled its flight is swift and almost noiseless. It occurs throughout Iowa in sandy areas, and within Minnesota has been taken at Albert Lea, Pipestone, Redwood Falls, Mahtomedi, and Fergus Falls.

Arphia xanthoptera Germ.

In size, general appearance, and coloration *Arphia xanthoptera* is extremely like the preceding and is subject to the same variations

of color of wings and body but may be separated by reference to the key. Like the preceding it is a midsummer species and is most common in sandy areas in the southern part of the State during late summer. Blatchley (The Orthoptera of Indiana, p. 257) states that in Indiana a third of the males have the wing coloration orange, while but a sixth of the females are so colored. In Iowa we have taken twenty specimens at one time, in the field, for examination. Of these nine were males and eleven females; seven of the females had red or orange wings, while but one male was so colored, and four females and eight males had yellow wings. Another peculiarity there noted was that the males were all notably dark in body color, save one, and the females uniformly of a lighter coloration. This examination was made August 10, 1909, and the facts, kept in mind through the collecting season, led to the conclusion that in Iowa, at least, the males are in general considerably darker than the females. The species is rather scarce in Minnesota and we have taken specimens only from Pipestone and Redwood Falls, although it will doubtless be found at other points when careful and continued collecting shall be done.

Arphia pseudonietana Thom.

Arphia pseudonietana is about the size of *A. sulphurea* but the coloration is extremely variable. The tegmina are of a gray to brown or nearly fuscous tone, but the wings are nearly always of a bright red color (Plate II, 1), though rarely forms are found in which the wings are a deep yellow. The pronotum frequently has a light area, anteriorly located, giving a "collared" effect. This is a very common insect especially in the western parts of the State in early spring and by May it is normally abundant at Fergus Falls and other points in the Red River Valley. By mid-July it has disappeared and again becomes common in late August and September. For the most part it is found in open places on dry soil, being often very abundant on gravel hills. It has a flight which is strong but not so vigorous as that of *carinata* or *xanthoptera*, and its aerial stridulation is less noticeable than in these. It is a very beautiful insect and in flight appears almost like some brilliant butterfly. On a clear, hot day in June at Fergus Falls, we once noted two males of this species standing facing one another about two inches apart. First one would raise the hind femora and rub them briskly against the sides of the tegmina a number of times, producing a dull rasping sound which to our ears was certainly poor music; then he would drop to a position of attention and his *vis-a-vis* would go through the same performance. This continued for some time and we at length left the two isolated "fiddlers"

on their hillside. Was this in some way a competition or merely for the pleasure of the music?

This species is attacked, especially in late fall, by a small fly (*Anthomyid?*) which rises and darts after the brightly marked locust while it is in flight, evidently seeking to deposit eggs or maggots upon the insect. This species has been taken at Fort Snelling, Gray Cloud Island, Mankato, Albert Lea, Pipestone, Redwood Falls, Monticello, Fergus Falls, Ada, Detroit, St. Cloud, and Mahtomedi.

The following is taken from Mr. Howard's insectary notes: "The eggs are laid in a slightly irregular clump at the bottom of a boot-shaped pocket. These pockets are either perpendicular for a distance of about three-quarters of an inch and then turned at nearly a right angle, or they may slant at a sharp angle with the surface of the soil with the basal portion more nearly parallel with the soil. The tube is not so compact and hard as with the *Melanopli*. Five tubes examined contained 21, 25, 21, 20, and 21 eggs respectively."

Arphia conspersa Scudd.

Arphia conspersa is structurally very similar to the following species but in typical forms may be readily separated by the characters given in the key. We have found it rather rare and local within our State, having taken it but twice, once at Pipestone in the southwestern part and again near St. Paul Park in the eastern part of the State. In both cases it was taken amid sparse grasses, such as *Sporobolus*, on very dry, gravelly soils. In both cases it was apparently few in numbers and careful search afforded but one or two specimens of this among the large numbers of *A. carinata* and *Melanopli* with which it was associated. In flight and in general appearance it bears considerable resemblance to *A. sulphurea*.

Arphia arcta Scudd.

Lugger has recorded two specimens of *Arphia arcta* from St. Anthony Park (Third Ann. Rept. of Entomologist, Minn. Exp. Sta., p. 143), but it has not been taken there or elsewhere in the State since. It does, however, occur in both Iowa and Nebraska near our borders and will doubtless be found again within our State. Since it has not been very generally described in recent publications the description is here quoted in full to aid in recognition of the species. "Head grayish brown above, yellowish elsewhere; the median carina of vertex broken at the posterior limit of the fastigium by the deeply impressed arcuate transverse furrow which marks the same, extending through the frontal costa nearly to the ocellus, expanding and forming

a loop at the extremity; lateral foveolae strongly and deeply impressed, narrowing anteriorly. Pronotum grayish brown, the upper surface unusually flat for an *Arphia*, rugulose, the median but little elevated, not laterally pinched at middle, regularly but slightly diminishing in height posteriorly. Tegmina profusely sprinkled with small grayish-fuscous spots, less abundant apically where the area is pellucid. Wings yellowish at base, pellucid to an unusual extent at tip (nearly one third of the ante-anal field is included in the pellucid area) making the transverse dusky bar narrower than in any species of *Arphia* known to me; the radial shoot toward the base, however, is unusually broad



Fig. 4. Normal Habitat of *Arphia sulphurea*

and long, equaling at its origin the entire breadth of that part of the wing and scarcely stopping short of the base. Hind femora brownish-yellow, externally with two broad, a little oblique, dusky transverse bands; hind tibiae pale yellow, with a broad fuscous cloud at tip and just before the middle. Length: male 21 mm., tegmina 22.5 mm., antennae 8.5 mm., hind femur 11.5 mm." The species was described from one male taken at Denver.

Arphia sulphurea Fabr.

Arphia sulphurea is one of our earliest forms and may often be taken in early spring in company with *Chortophaga viridifasciata*. It

is of a more uniform coloration than any of our other species and the wings are uniformly a bright sulphur-yellow in the basal field. The body and tegmina are usually sprinkled with fine fuscous dots and at the inner margin of the tegmina, especially in males, there is often a narrow light-colored area giving the effect of a light dorsal bar when the tegmina are closed. There is usually a pale annulation of the hind femur near the base and a similarly colored pregenicular annulation. The hind tibiae are dusky or blue black with a pale annulus near the base.

This insect is especially fond of rather open woodlands and is strong and vigorous with a swift and well-sustained flight. It is very alert and active and with its effectively protective coloration is not easy to capture even where abundant. Like most of the genus it stridulates while in flight. It is quite gregarious and frequents certain favored localities, being numerous in these spots, while in others of apparently similar type it may be entirely absent. We have found it quite widely scattered and it is doubtless very generally distributed throughout the State. We have taken it at Winona, Albert Lea, Mankato, Worthington, Pipestone, Brown Valley, Fergus Falls, Duluth, Mahtomedi, and St. Anthony Park.

CHORTOPHAGA Sauss.

The Chortophagas are insects of medium size with somewhat slender form, more or less distinctly compressed, punctate or finely rugose body, coloration usually greenish to brownish and surface more or less finely pubescent. Vertex nearly horizontal, triangular, apically truncate, the lateral carinae well marked though not prominent; median carina weak or wanting, often faintly visible on the posterior part of the head behind the eye; foveolae shallow, triangular, broadest next the eye. Antennae rather short and somewhat flattened. Pronotum with disk tectate, constricted near the front and considerably expanded posteriorly, its front margin broadly obtuse-angulate, hind margin acute-angled although with the point often rounded; median carina strong, faintly notched before the middle by the principal sulcus, which is nowhere strongly developed; lateral carinae distinct only on the anterior part of the metazona and rounded or obsolescent posteriorly, more strongly marked in the male. The tegmina are rather narrow and exceed the abdomen nearly the whole apical half, especially in the discoidal field, membranaceous and traversed by a series of straight and nearly parallel veinlets; inner wings nebulous, often more or less tinged with yellow, the veins somewhat incrassate. This genus pre-

sents certain characters of the *Tryxalinae*, with which it was formerly classed but has a predominance of Oedipodine characters.

Chortophaga viridifasciata DeG.

Excluding the *Tettigidae*, *Chortophaga viridifasciata* may be considered our orthopteran "harbinger of spring," being normally the first of this order to appear. We have noted it in some numbers near Minneapolis as early as April 1, while in Iowa we have taken it a month earlier. It is found in two color phases, a smoky brown and a distinctly green form. The green ones are predominantly females, although males of this color are occasionally found. Some of the green form are very beautifully variegated with pink or lavender on face, antennae, pronotal carinae, and posterior femora. Bruner, speaking of this species, states that in Nebraska the brown form appears first in the spring and the green form later in the season, but in both Iowa and Minnesota we have noted that the two forms appear simultaneously, the brown form being relatively more abundant in clear fields and open woods where it occurs with *Arphia sulphurea*, while the green form predominates in grassy spots, such as meadows and borders of streams. The species becomes very generally distributed later in the season and both color forms are together in almost any place where grasses and low vegetation offer sustenance. It is apparently double-brooded since we have found the young swarming in lowland meadows as early as June 26 and again in September. The males are very active and have a swift, low flight, often somewhat broken by zigzags and usually turning abruptly at an angle from the general direction of flight upon alighting. The females are heavier and have a somewhat labored flight usually ending by an abrupt dive into weeds or other concealing vegetation.

Hancock (Nature Sketches in Temperate America, p. 410) has given the following interesting notes: "At Miller's, Ind., June fifth, I found a female laying her eggs in damp sand at the border of a pond. When I approached she had her abdomen buried quite deeply. After I waited about fifteen minutes she moved away from the place. I proceeded very carefully to dig the earth away to one side of the burrow and then it was found to be twenty-seven millimeters deep, and at the bottom, the eggs, twenty-five in number, were laid in a compactly cemented mass. They were bound together with a whitish mucous and there was quite an amount of this substance lying above the eggs in the burrow. The smaller poles or ends of the eggs were directed upward as is usual with Acridians. The eggs measured four and one half millimeters in length and about one millimeter in width and they

were slightly curved in their long axes. Both ends were rounded, but the cephalic or head end was slightly smaller than the opposite one and further distinguished in the fresh eggs by the very small densely opaque, cap-like structure occupying the tip." This species has been found throughout the State and at times in favored localities increases to sufficient numbers to do noticeable damage to crops.

ENCOPTOLOPHUS Scudd.

Body of medium size, somewhat slender though not so much so as in *Chortophaga*, somewhat compressed; the head slightly swollen; vertex more broadly triangular than in the preceding and somewhat declivent, lateral carinae weak, apex obtuse in females, median carina present but terminating at middle of disk. The antennae rather long and slender, longer than head and pronotum together, especially in the males, the joints somewhat flattened. Pronotum with disk flattened, the median carina distinct or strong, notched near the middle; lateral carinae visible only on the metazona. Anterior margin of the pronotum truncate, hind margin sharply angulate; lateral lobes deeper than long, much wrinkled, front and hind margins nearly straight and vertical, the posterior more oblique and with the lower corner rounded. Pronotum less constricted anteriorly than in the preceding genus. Tegmina broad and longer than the abdomen with the intercalary vein distinctly nearer the ulnar than the median. But one species is known in Minnesota.

Encoptolophus sordidus Burm.

The color of *Encoptolophus sordidus* (Plate I, 8) varies through the shades of brown, and the somewhat mottled pattern suggests some of the dark forms of *Hippiscus*. There is usually a light-colored, pink-tinged, X-shaped mark on the disk of the pronotum, very conspicuous in dark specimens. The tegmina are marked with two transverse, light-colored bars near the middle, which contrast with two larger fuscous patches between and on either side of them; the inner wings are yellow, somewhat clearer toward the base and smoky apically. The antennae are brownish, darker apically. The hind femora are banded or almost covered with fuscous; hind tibiae dark, with a pale annulation near the base.

This species matures late in summer and during August and early fall may be found in some numbers in dry sandy areas. We have generally taken it amid such vegetation as *Aristida basiramea* Eng. and *Bouteloua hirsuta* Lag., although it is also found even far out in culti-

vated fields, in spots where the growth is sparse. The male usually stridulates rather loudly during flight, which while swift is not prolonged. On two occasions we have noted the female of this species ovipositing in the somewhat compact earth at the mouth of a gopher hole. We have taken this insect at Pipestone, Worthington, Redwood Falls, Granite Falls, New Ulm, Mankato, Fergus Falls, and Mahtomedi, and it doubtless occurs throughout the southern and western part of the State.

CAMNULA Stal.

Size rather small for an Oedipodid, somewhat stouter than the preceding, the head more distinctly compressed; vertex with the disk subtriangular, with rounded angles in the male and almost ovate in the female; median carina visible posteriorly from the disk in both sexes. Blatchley (The Orthoptera of Indiana, p. 261) says the median carina of the vertex is absent in the male, but in a series of 80 before us, we find the median carina distinct in 66, weak in 6, and absent in but 8 males. Lateral carinae of vertex strong and more or less incurved posteriorly. Antennae short, not exceeding the head and pronotum, filiform. Pronotum with disk narrowed anteriorly and gradually widened to the posterior margin, which is bluntly angulate; surface of the disk flat, more or less rugulose or tuberculate on the metazona, but never strongly so as in *Hippiscus*; median carina distinctly elevated throughout, distinctly though faintly notched before the middle; lateral carinae distinct on both prozona and metazona, in the female broken or obsolescent at the principal sulcus; lateral lobes of pronotum vertical, deeper than long, both margins nearly straight and lower angles not much rounded. Tegmina rather narrow, surpassing the abdomen, the apical third somewhat reticulate. Hind femora equaling or surpassing the abdomen, not stout. A single species occurs throughout Canada and the northern part of the United States, from the Atlantic to the Pacific.

Camnula pellucida Scudd.

The color of *Camnula pellucida* is somewhat variable (Plate I, 5) but in general is a light brown, sometimes ferruginous; antennae yellow at base and darker apically. A pallid area is usually visible below the eyes; postocular band narrow at the eye, widened behind on the lateral lobe of the prozona, extending downward over much of the surface and usually more or less indistinctly connected with the area on the opposite lobe of the prozona by a brownish bar

across the disk; lobes and disk of metazona commonly much lighter in coloration, giving sometimes a distinctly "collared" form. Tegmina with a longitudinal, humeral, light stripe, and variably maculate with rather large, rounded, dark spots; hind femora yellowish with two

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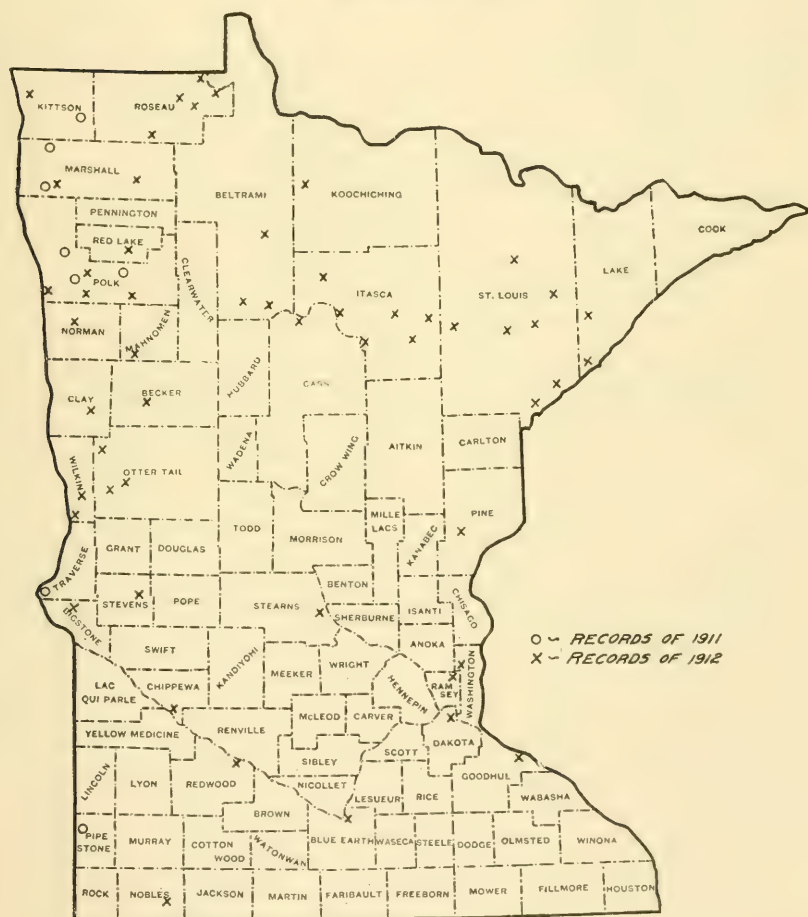


Fig. 5. Distribution of *Camnula pellucida*

or three oblique dark bars and sometimes a pregenicular dark annulation; hind tibiae yellowish, sometimes reddish toward apex, and often marked with a narrow, faintly defined annulation of brown near the base.

"In the markings of tegmina, form and color, *pellucida* looks like

a diminutive *Hippiscus*. It varies much in size and tegminal markings." According to Hancock this species is mature in Illinois by June 20. We have taken it in considerable numbers at Crookston, by June 25, when many were freshly moulted. Various writers, referring to the habits of this species in western states, have stated that it apparently dislikes or avoids alfalfa, but in our cages it has eaten this plant without any hesitation and observations in the field have convinced us that it will attack fields of alfalfa as readily as any of our other species. During the season of 1912 we found this insect abundant throughout the north part of the State and particularly in the relatively uncultivated areas of the iron ranges, where it was generally the dominant species. From its abundance at these points and from the fact that it is a species capable of rather extended migrations, it is of considerable economic interest, since a series of dry and favorable seasons may result in serious damage to crops from this insect.

One fact worthy of notice regarding this species is that in the field it is apparently more free from the attacks of *Trombidium* and other parasites and less susceptible to fungous diseases than the *Melanopli*, although confined in our cages it died off largely from fungous troubles. Normally it is found on high, dry soil, and at times in some abundance even in the more open parts of forests. Its flight is swift and direct without marked aerial stridulation. From the two light lines on the tegmina it may be confused with *Melanoplus bivittatus*, and in one case we noted a trained entomologist confuse it with *M. atlantis*, from the narrow and sometimes faintly notched subgenital of the male. In the field this species oviposits during the latter part of August, the pods being rather short, stout, considerably curved, and not firmly cemented. These pods are deposited just below the surface of the soil, among the roots of grasses or in some cases even above the surface amid the dead grass. Pods examined by us contained from 20 to 30 eggs each. During the season of 1911 we found this insect rather rare, except in the north part of the State, taking it only at Brown Valley and Pipestone and at points north of Crookston, while during 1912 it was found in some numbers at Fergus Falls, Granite Falls, Redwood Falls, Mankato, St. Cloud, Mahomed, Gray Cloud Island, and at every point visited by us north of a line drawn from Duluth to Crookston.

HIPPISCUS Sauss.

The genus *Hippiscus* includes the largest and some of the most common of our *Oedipodinae*. The species are usually of robust form, the head large and subglobose, the vertex usually more or less decli-

vent, broadly triangular, with the apex obtuse; lateral carinae distinct, median usually present at least in the basal portion; foveolae present, though not deep or prominent and usually triangular in form; the antennae are not longer than the head and pronotum, filiform and in some forms with the joints somewhat flattened, especially in the apical half. The pronotum has the disk flat or nearly so and the surface distinctly tuberculate or rugose; the median carina distinct and in most of our species cut by but one sulcus, although in *H. zapotecus* and *H. tigrinus* it is cut by two sulci; the lateral carinae pass the principal sulcus without being noticeably cut by it in most species, but are often strongly rugose or cristulate at that point. Tegmina exceeding the abdomen and usually with at least the apical third quadrately reticulate; the basal area of the wing, in all our species, red or yellow, though blue in certain western species, this area usually bounded externally by a curved black or fuscous bar of varying width. The hind femora are stout, usually considerably dilated at the base, often with the inner face more or less marked with bright colors.

These insects are very similar in general appearance and many are dimorphic as to color of wings, thus leading rather easily to confusion in specific identity. The following key will serve to distinguish the species found within our area:

- Rugosities of the metazona arranged in series more or less definitely parallel with the hind margin
 - Antennae of males not especially attenuate; median carina of pronotum intersected by only one sulcus *haldemani*
 - Antennae of males attenuate; median carina of pronotum intersected by two sulci, the anterior one usually weak *tigrinus*
- Rugosities of the metazona not definitely arranged into series parallel with the hind margin
 - Median carina of pronotum intersected by but one sulcus
 - Anterior extremity of vertical scutellum not prolonged, narrowing rapidly in front *rugosus*
 - Anterior extremity of vertical scutellum prolonged and narrowing very gradually in front *tuberculatus*
 - Median carina of pronotum intersected by two sulci; inner face of hind femora bright red in whole or in large part *zapotecus*

Hippiscus haldemani Scudd.

Hippiscus haldemani has been much confused with others of the genus but may be separated by the arrangement of the rugae of the metazona into series more or less definitely parallel with the oblique sides of the hind margin. The hind margin of the metazona is right-angled in males and obtuse-angled in females. The general color is usually a grayish brown variously maculate with dark brown spots. The wings are yellow, in all specimens yet taken in this State, and the hind tibiae usually yellow, more or less tinged with dull orange. The

tegmina are long and surpass the abdomen, often as much as one fourth of their length. We have noted this species only at Fergus Falls, Granite Falls, and St. Paul Park. It is notably more solitary in habit than most of the members of this genus and in all cases mentioned above but one specimen was taken, always amid the low scattered grasses of very dry soils.

Hippiscus tigrinus Scudd.

Dark brownish fuscous, of robust form and medium size. Head narrowed above and rugulose; fastigium of vertex distinct, with rather sharp, though not high bounding, walls, closed behind by a distinct, though slight, transverse, arcuate carina; lateral foveolae not deeply impressed, triangular; the median foveola, between their tips, slightly impressed; frontal costa moderately broad, narrowed at the summit much more than below the ocellus, deeply sulcate at the ocellus, and plane at the considerably expanded base. Pronotum expanding considerably on the metazona, which is a little tumid centrally, the rugosities of the latter, which are considerable, ranged more or less distinctly into series parallel to the sides of the process; median carina subobsolete or at least depressed between the sulci, distinctly arched on the metazona; lateral canthi distinct and sharp in the middle of the pronotum, a faint, rather ashen band next their inner side; posterior process of the metazona rectangulate. Tegmina ashen gray, brownish at the base, vitreous on the apical third or more, the transverse bars dark brownish fuscous, mostly crossing the wing, those of the apical half not at all rounded, with rare exceptions with ill-defined irregular margins, and extending, though fainter, to the tip of the wing; sutural line testaceous. Wing very pallid citrine at base, pellucid at tip, occasionally with one or two fuliginous cellular spots at tip, the veins and cross-veins blackish on apical portion, yellowish on basal, with a broad, subequal, arcuate, dark, fusco-fuliginous, median, scarcely tapering band, leaving four or five lobes free, separated by a yellow line from the humeral vitta, which extends from very nearly as far out to the base of the wing, the costal margin fusco-testaceous. Hind femora externally brownish fuscous with only obscure, if any darker, very oblique bars, dirty clay-yellow below, the under surface, like the tibiae and tarsi, luteous, the spines black-tipped. Length, female, 39 mm., tegmina 37 mm.

The species is here included upon Lugger's record (Third Ann. Rept. of Entomologist, Minn. Exp. Sta., 1897, p. 152) where he mentions "two specimens" but gives no definite locality. We have seen but one specimen of this species, taken in northwestern Iowa by Ball

and now in the collection of Iowa State College at Ames. It has been taken from Nebraska to Arizona and the few specimens taken in Iowa and Minnesota probably represent merely the stragglers along its eastern range.

Hippiscus rugosus Scudd.

Hippiscus rugosus is a well-known species, which while not common, has been taken at several points within the State and when more extensive collections have been made, will doubtless be found nearly as common here as in Iowa. The following is taken from notes made upon this species while in Iowa: "From the latter part of July until late in the fall, this is the most abundant member of this genus and appears to be very generally distributed throughout the State, although somewhat less abundant in the northern counties. It is found in dry places, especially along the margins of woods or thickets. It is generally darker than other members of the genus and the disk of the pronotum is very uniformly marked with a light-colored X-mark. The wings vary from yellow to a reddish orange. We have found males as late as October 24, and females a week or more later." In Minnesota the species matures late in August and we have taken it at Redwood Falls, Pipestone, Mankato, Albert Lea, Mahtomedi, and Fergus Falls.

Hippiscus tuberculatus Pal. de Beauv.

There is considerable variation in color in *Hippiscus tuberculatus*, although the following, taken from Scudder, will give a good idea of its normal form here: "Prevailing color a light ashy plumbeous, slightly darker above, specked with dark plumbeous, tinged slightly beneath with reddish; eyes dark brown speckled with yellowish brown, and with a narrow, slightly curved median streak slightly upturned behind. Antennae dirty yellowish at base, beyond of the color of the head. The pronotum with a longitudinal dark brown streak with indistinct edges along the middle of the lateral lobes, and from the middle of this a descending vertical streak scarcely paler than the ground; posterior edge of the pronotum a yellowish brown, of the color of boxwood. Tegmina of the body color or blotched with fuscous and blackish and with the axillary fold yellowish brown. Wings coral-red at base, the arcuate band fuscous, deepening to black, the humeral line pale yellow and the apex nearly hyaline. Legs of the body color, the inside of the hind femora having the basal half a Prussian blue, the distal half very dull lemon-yellow, with a transverse streak of deep blue at one third the distance from the middle; hind tibiae dull lemon-yellow; hind tarsi tinged with reddish."

This large and well-marked species is among the earliest of our Orthoptera and has been noted in Minnesota as early as the latter part of April, while in Iowa we have taken it fully matured by March 12, although this was, of course, exceptional. The dark markings of the tegmina, especially toward the base, have a tendency to become broadly triangular in form rather than rounded or transverse as in most of the species of this genus. The wings are quite uniform in their coral, or sometimes pinkish, red, although rarely yellow-winged forms are taken. The species can not easily be confused with others because of its quite distinct specific characters and also because of its occurrence at a time when very few other species of this genus, within our area, are mature, since nearly all have disappeared by the first of July. The species is to be found in nearly all parts of the State but appears quite local and colonies may be found in the same locality year after year. The young appear in July or August. The species frequents dry places, sandy spots along the edge of streams being especially favored. Both sexes have a strong and swift flight, although the female often relies upon concealment for escape. The male has an aerial stridulation much like that of *Arphia*, although when startled it often flies noiselessly. We have taken it in most parts of the State, although it is apparently less abundant in the Red River Valley.

Hippiscus zapotecus Scudd.

Hippiscus zapotecus, which has hitherto been reported almost entirely from the West and Southwest, has been found in considerable numbers in Ottertail County and other parts of the Red River Valley. Since it has the median carina of the pronotum cut by *two sulci*, it is readily set apart from most species of this genus. It was found in early spring, considerable numbers being taken by May 1, having doubtless been mature for some time even at that date. It was taken in every case upon high gravelly hills and associated with a dwarf sage (*Artemisia cana* Pursh.).

The following description taken from specimens before us may be of interest, since descriptions of this species are not readily obtainable: General color a light grayish brown, more or less suffused with pink on the pronotum and face, maculate with dark fuscous; tegmina as long as (female), or surpassing (male), the abdomen, light grayish brown, heavily marked with rather small squarish spots of dark brown or fuscous, the spots not much coalesced into large areas as in most species of the genus; a well-marked light stripe along the axillary fold, broadening, and the two stripes meeting at a point but little behind the base of posterior femora; abdomen more or less maculate with

dark spots, frequently coalescing into indistinctly defined bands. The hind femora stout and depressed, the lower carina very strong, color about as in body, with three broad, oblique, dark bands in the superior field and with small dark spots along the extended inferior carina; the inner face commonly all, rarely nearly all, dark coral-red, very bright in life; hind tibiae bright coral-red, the outer face with a variable pale



Fig. 6. Range of *Hippiscus zapotecus*

or whitish area at base; hind tarsi red above and yellow below. Disk of the vertex declivent, roughly pentagonal and anteriorly extended but blunt at apex; lateral carina distinct but not strong; median carina beginning at a point opposite the anterior edge of the eyes, with sometimes tuberculations anterior to this, and extending back to front of pronotum, in some with faintly indicated supplementary carina parallel to it behind the disk; eyes maculate, brownish with yellowish streaks; frontal costa strong, sulcate between the antennae, and not widely separated below; antennae long, considerably longer than the head and

pronotum together in the male, filiform, dark smoky brownish. Pronotum broadly angulate at anterior margin and rectangular or sometimes obtusely angulate at posterior margin; its median carina not much elevated, distinctly cut by *two sulci*, in the female sometimes almost obsolete between them; lateral canthi distinct though broken and somewhat irregular on the metazona. The whole disk is covered with heavy tubercles not coalescent save at the sulci and there variably so; a row of these black-tipped tubercles follows the anterior margin of the pronotum. On the anterior portion of the disk is a rather large dark spot, triangular in form, broadest behind, bounded by lighter, narrow bands giving a faintly defined X-mark. The lateral lobes of the pronotum are deeper than broad, concave by the constriction at the sulcus and bearing anteriorly below the middle an irregular dark spot. Fore and middle legs plumbeous, the middle femora with three ill-defined dark transverse bars. Measurements from specimens before us are as follows: male, length 27.5 mm., tegmina 25 to 28 mm., hind femora 15.5 to 16.5 mm., antennae 16 mm.; female, length 40 mm., tegmina 31 mm., hind femora 16 to 18 mm., antennae 12.5 mm.

The following notes are from observations made during the past two years in Ottertail County: May 15, 1911. Noted many specimens of this species, adult males and females and the immature forms or nymphs. The males in particular are quite active, although not easily aroused. They frequently crouch amid the sparse vegetation and rely upon concealment. To-day the males were far more numerous or the females unusually well concealed, as I saw but few of them, while the males were quite plenty.

The male is very active and alert, flying with a sharp, crackling, aerial stridulation, and near the end of the flight invariably makes an abrupt turn or zigzag and immediately upon alighting runs rapidly a few inches from the spot. In bright weather they are extremely wary and difficult to capture; even when in the net they frequently crouch close to the ground, perfectly motionless, and their coloration, despite its striking colors, blends so perfectly with the lights and shadows among the dead vegetation as to render them almost invisible. They are as quick to seize an opportunity and escape, when the net is moved incautiously in searching for them, as some of the *Cicindelidae*. The females, although large and bulky, can fly well when alarmed. We noted one arise and fly a distance of eighty feet or more at a height of about ten feet, crossing a small hillock and alighting on the opposite side, where we were unable to locate her again.

June 6. While driving with Mr. Metzger, we noted from the roadside a dense growth of *Artemisia cana* on a high dry hillside and, recalling the close association of this plant with *H. zapotecus*, I made

the statement that I would get out and collect some specimens of this *Hippiscus*. Upon making a search, we found several specimens, much to Mr. Metzger's astonishment. The almost invariable rule in this locality is that where we find this dwarf sage on gravelly hillsides, we have taken this insect.

The only record of this species in this part of the country was based upon a single specimen taken by Dr. J. A. Allen, at Denison, Iowa, July 15, 1867. Walker has twice reported taking it in Canada, while all other records are from Colorado and westward. We have taken it in abundance throughout Ottertail and Wilkin counties and at Halstad, Fertile, and Hallock.

DISSOSTEIRA Scudd.

The body of the *Dissosteira* is slender and somewhat compressed, with the head prominent; the vertex more or less tumid, declivent, the disk subpentagonal or nearly ovate, the lateral foveolae trigonal; lateral carina low and the median present but very weak. The pronotum is tectate on the prozona and flattened on the metazona; the median carina strong and sharp, strongly arched on the metazona; deeply but narrowly notched before the middle; lateral lobes deeper than broad. anterior and posterior margins nearly straight, the anterior vertical and the posterior more or less oblique; inferior margin posteriorly rounded and anteriorly ascending; tegmina long and quite broad, the apical third membranaceous; wings long and broad, in our species, blackish with a light outer margin. But one species is known to occur in this State.

Dissosteira carolina L.

Dissosteira carolina is one of the most common of our Orthoptera (Plate II, 2 and 3) and possibly the one most generally noticed by the great mass of persons not particularly interested in this group, as it may be seen almost everywhere during midsummer. It is an insect primarily of dusty places and may be found wherever bare earth, sand, or clay is exposed. It is moreover equally at home in the busy streets of a city or the deserted roadways of the country. We may find it also in meadows, on railway embankments, or along the margins of lakes or streams. Wherever we find this versatile species we may note that its coloration fits perfectly the background of its habitation. There appears to be a rather definite adaptation of coloration to environment, since in a large series taken upon open sandbars, there is usually a predominance of light-colored forms, more or less closely simulating the coloration of the sandbar, while in a series taken

upon dark soils, the darker forms, approaching the coloration of the soils, predominate. Hancock (Nature Sketches in Temperate America, pp. 346, 347) has described a series of experiments made to determine the effect of environment, and more especially of soil background, upon these insects. His conclusions may be quoted here. "In these experiments, together with others that I have made, the evidence indicates that the Carolina locust does not change abruptly at the critical period during the last ecdysis, or moult, from one color to another but a change takes place in the adult gradually after the last moult. Whether this is in sympathy with the surroundings is not definitely proven. But the indication is that the hypodermal cells lying



Fig. 7. Normal Habitat of *Dissosteira carolina* C. W. Howard

in the integument of the newly moulted adult are very sensitive to light and humidity and are capable, under the effects of these stimuli, of responding by changing color in accordance with that of the habitat." When in flight the broad expanse of wing and the contrasting colors of the largely black surface and the light outer margin make it a very conspicuous object, but immediately upon alighting the insect normally blends so perfectly into the color scheme of the background as to be almost indistinguishable.

The males of this species frequently exhibit a very interesting performance in midsummer. They will rise into the air a few feet and poise there, the wings being vibrated rapidly with a whirring sound

for a time until the insect, tiring, drops again to the earth. From a distance this performance resembles the hovering of the "Mourning Cloak" butterfly, *Euranesia antiopa*, more than the actions of a grasshopper. This habit is occasionally seen in a few other related insects, such as some of the *Arphias*, *Camula pellucida*, and *Circotettix verruculatus*. It has been thought by some to be in some way attractive to the opposite sex, but as Hancock has noted, we often find this demonstration occurring when only males are near, and on the whole it appears more likely a form of play, possibly akin to the jumping contests of small boys. The insect is very social in its habits and individuals meeting will sometimes pause and wave the antennae with every appearance of an informal conversation. The males are very ardent in their courtship and on one occasion we found four unsuccessful males clinging to a mating pair so closely as to form a compact mass of locusts, not even releasing this hold when we rolled them gently down an incline. In Minnesota the species matures early in June and may be found until severe frosts in the fall. We have found the immature forms along the roadsides of Redwood County early in May, squatting among low and sparse vegetation, apparently enjoying the warmth of the sun.

Like many others of our locusts this species is very subject to the attack of a fungous disease, *Empusa grylli*, and late in summer the dead and partly bleached bodies may be seen attached to the tops of weeds. This locust is one of those which are of economic importance within our area, since it often does considerable damage to growing crops. This damage is usually confined to the edges of fields along roadsides, although in fields of corn, potatoes, and of certain other cultivated crops which present dusty surfaces, the insect may be found far out in the fields. The females begin to oviposit early in August or even late in July, and may often be noted drilling into soil so firmly packed as to appear hopeless. We have seen them drilling in the hard-packed roadbed of a well-traveled clay road and on one occasion at Crookston we watched one drilling in a hard cinder path in a park. A small boy who accompanied us sagely remarked that he guessed they "might even try a cement walk." We have seen this species at nearly every point visited within the State, although in the extreme north it is relatively scarce, its place being taken by *Circotettix verruculatus*, an insect of very similar general appearance and habits.

SPHARAGEMON Scudd.

The body of *Spharagemon* is rather slender and somewhat compressed, with the head more or less swollen; vertex rather broadly

triangular, though more or less rounded behind by the incurving of the lateral carinae, in some forms suggesting that of *Dissosteira*. The lateral carinae are weak and the median, although very faint, is indicated especially in the male; foveolae rather large, shallow, triangular; the frontal costa sulcate, at least below the ocellus; antennae rather long, usually attaining the tip of the hind femora, the basal joints somewhat flattened. Pronotum tectate on the prozona and flattened on the metazona, the median carina strong and high, cut before the middle by a deep, sometimes oblique, notch; lateral canthi, in males, distinct on the metazona, cut by the sulcus and less distinct on the prozona; in the female they are rounded upon the metazona. The tegmina are always well developed but shorter and relatively somewhat narrower than in *Dissosteira*, exceeding the tip of hind femora in both sexes; wings with colored basal area yellow, with a dark arcuate band near the middle. Hind femora stout, more or less depressed, exceeding the tip of the abdomen; hind tibiae variable in color, in ours with at least the apical portion red. The species belonging to this genus are extremely alike and difficult to separate. Although certain of the species found within our State have been reduced to subspecies or varieties by recent authors, we prefer, for the purposes of this paper, to consider all of equal rank. The following key will aid in separating our species:

Posterior tibiae tricolored, basally whitish, a broad median black or fuscous annulation, and the apical half red; size rather large; tegmina with two more or less distinct transverse fuscous bars *bolli*

Posterior tibiae normally red, sometimes paler at the base but never with a median fuscous annulation

Median carina of pronotum high and not sinuate on the prozona

Large species; head rather narrowed above

collare

Small species; head quadrate above; tegmina widest at costal dilation and arcuate toward apex

wyomingianum

Median carina of pronotum lower and usually sinuate on prozona; width of vertex between the eyes distinctly more than width of one eye *aequale*

Spharagemon bolli Scudd.

Spharagemon bolli is preëminently a lover of dry soil and wooded places and has been noted through a large portion of the State, especially in the eastern half. It is a large and well-marked species, the somewhat conspicuous tricolored hind tibiae readily serving to identify it in the field. The body colors are quite variable but normally a dark or grayish brown, the tegmina marked with minute blackish spots, which, especially in the male, are aggregated into more or less distinct transverse bars. In males the median carina of the pronotum is more elevated than in the female. Both sexes have a strong, swift flight with a distinct rustling of the wings, which, however, is under control of the insect. The same dry, somewhat open woods that abounds in

Arphia sulphurea in the spring, will often be found fully as well stocked with this species late in summer and fall and the general appearance of the two insects being somewhat alike may lead the casual observer to think it one form continuous throughout the season. Like *Hippiscus tuberculatus*, this species appears to have a distinct liking for certain localities and may be taken at these spots year after year, while absent at others in the vicinity apparently equally favorable. This species has been taken at Red Wing, Mahtomedi, Mankato, St. Cloud, Duluth, Tower, Cass Lake, Bena, Blackduck, and Greenbush. For some unexplained reason we have not seen this species at any point in the Red River Valley.

Spharagemon collaris Scudd.

Spharagemon collaris and the two following species are so closely related that in some forms specific separation is almost impossible, and is in any case a purely arbitrary matter. In its typical form this species is distinguishable in the field by the light "collar" which is really due to the much lighter coloration of the metazona and a portion of the lateral lobes. In these forms the face and the base of the posterior femora are usually also of a lighter color. In the western parts of the State and especially in the Red River Valley, this is an abundant species along roadsides and in dry places, even in open woods. At Crookston a certain sandy hillside along Red Lake River has yielded this form at any time during the summers of 1911 and 1912. The species matures in Minnesota about the middle of June and may be taken until late in the fall. Through the eastern and southern parts of the State this "collared" form appears less common than in the western part of Minnesota, but we have taken specimens near Duluth and Hinckley. The form without a distinct "collar," most of which belongs to what has been classed as variety *scudderi*, is the common form in the eastern part of the State and has been taken at White Bear, Winona, and Albert Lea. It is similar in habits and habitat to the typical form.

Spharagemon wyomingianum Thom.

Spharagemon wyomingianum is considerably smaller than the preceding although very similar, and while distinguishable by the characters given in the key, in typical forms, yet intergrades with it in most confusing fashion. Morse has classed it as a variety of *S. collaris*, but, as previously stated, we prefer, for the purposes of this paper, to consider it as of specific rank. It is very similar in habits to the following, which in some respects it appears to resemble even more closely

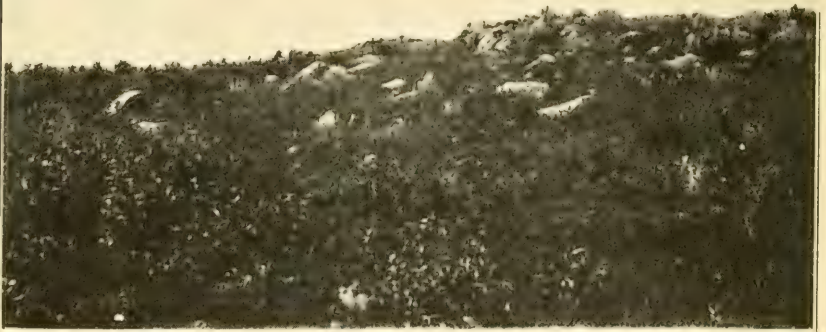


Fig. 8. Normal Habitat of *Spharagemon collaris* and *S. aequalis*

than it does *S. collare*. It is of lighter coloration and more uniformly maculate with small brownish spots, and in our specimens has usually a distinctly pink tinge. We have, as yet, found this species only in the southeastern portion of the State, usually on the sandy margins of the Mississippi and its tributaries. Upon the almost clear sand which it frequents, its light color and faintly marked pattern blend beautifully with the lights and shadows, rendering it almost invisible until it moves. Its flight is swift and strong, though not usually prolonged, and it rises with almost the swiftness of a *Cicindela*.

Spharagemon aequale Say.

Spharagemon aequale is larger than the preceding species and in our specimens very uniformly darker in color but very similar in structure to both that and *S. collare*. The carina of the pronotum is lower than in the preceding group and upon the prozona normally sinuate; the vertex is also somewhat broader. In all of our material the inner face of the hind femora is quite strongly suffused with red, especially in the basal portion, and the longitudinal dark bar is strong and distinct. We have found this species only on sandy soil in open places and usually with such scattered plant formations as the *Oenotheras*, *Chenopodii*, and tufted grasses. It is very active and alert and has a strong flight, more prolonged than in most of this genus and has also the habit of running for some distance immediately upon alighting, frequently at an angle with the direction of flight, thus making it quite difficult to capture. In early morning, while the dew is still upon the vegetation, and late in the evening, it perches upon tall weeds and is generally rather sluggish. We have at times picked them from these resting places by hand in early morning, when in bright midday at the same spot it was difficult to take them even with a net. The species matures at Fergus Falls by early July. We have taken this insect at Mahtomedi, Mankato, Redwood Falls, Granite Falls, and Fergus Falls. We have also taken nymphs of what appear to be this species at Hibbing and Vermillion Lake in the northern part of the State.

MESTOBREGMA Scudd.

Mestobregma is a genus containing insects varying from small to medium size. The body is slender and compressed; the head prominent, considerably elevated above the plane of the pronotum; disk of vertex with the posterior portion short and broad, tumid, the anterior portion narrowing rapidly and very strongly declivent; lateral carinae strong and high, extending from a point opposite the middle of the

eyes forward into the facial costa; median carina wanting or sometimes indicated by very faint tubercles in the disk; the lateral foveolae rather strongly marked, in our species triangular, the ocellus at the lower outer angle. Antennae about the length of the hind femora, flattened more strongly on one side than on the other so as to form one sharp edge. Pronotum moderately constricted before the middle, the front margin truncate, the hind margin rectangulate. Tegmina surpassing the hind femora, narrow, the tip broadly rounded, the apical half membranaceous. Posterior femora rather slender, reaching the tip of the abdomen in the females and considerably surpassing it in the males. But one species has been taken in Minnesota.



Fig. 9. Normal Habitat of *Mestobregma cinctum* and *Arphia pseudonietana*
C. W. Howard

Mestobregma cinctum Thom.

Mestobregma cinctum is a very alert and active little insect, found in various parts of the State and apparently rather generally distributed within our area. In size, general coloration, and flight it strongly resembles *Psinidia fenestralis*, although much more common, but may readily be distinguished from that species by the shorter antennae, which, while basally somewhat flattened, are not so strongly depressed as in *Psinidia*. The posterior tibiae also differ in the two; in *Mestobregma* the tibiae are pale blue with a whitish ring usually present

near the base, while in *Psinidia* they are whitish with a dark ring near each end and usually a broad one near the middle. There is also a difference in the maculation of the tegmina, which in *Mestobregma* have in the costal field two squarish areas separated by an oblong light-colored spot, while in *Psinidia* the area is marked with numerous small spots. We have found that in the field the wings of *Mestobregma* are subject to considerable variation in coloration, ranging from the typical form with the basal third lemon-yellow and a narrow, curved, fuscous, median band, to forms in which the basal third is whitish or transparent and with no trace of a curved fuscous band. This variation appears to be entirely individual and in no way influenced by the age of the insects, as we have found the different forms in specimens still soft from the final moulting and in ragged and worn specimens late in the season; neither does environment appear to influence the coloration as we have noted them alike on clear sand, with such plant formations as *Grindelia*, *Froelichia*, and *Croton*, and also in open woodlands undergrown by grasses. In Minnesota we have taken this species at Fergus Falls, Granite Falls, Redwood Falls, Pipestone, Ada, Hawley, Bemidji, Hibbing, Vermillion Lake, Duluth, Hinckley, and Mahtomedi.

PSINIDIA Stal.

Small and slender insects with the head large and prominent and the occiput strongly elevated; disk of the vertex broad posteriorly, narrowing rapidly anteriorly, quite strongly declivent; lateral carinae sharp, nearly converging in front; foveolae rather small and sub-circular; the frontal costa sulcate throughout, very narrow above and gradually expanded below. Antennae long, especially in the males, the joints of the basal half strongly flattened and with the edges rising somewhat above the center. Pronotum with the disk nearly flat, granulate, the median carina distinct and twice cut by the sulci; front margin of the pronotal disk truncate, hind margin acute-angled; lateral carinae distinct on the metazona and weaker on the prozona; lateral lobes deeper than broad, front margin straight and posterior margin somewhat concave, inferior margin arcuate and quite strongly ascending anteriorly. Tegmina rather narrow, exceeding the abdomen in both sexes and strongly coriaceous in the basal half. Inner wings red at base, the arcuate dark band submedian and considerably expanded posteriorly. Hind femora reaching or surpassing the tip of the abdomen; hind tibiae annulate. This genus is represented by one species, which is found throughout eastern Canada and the United States.

Psinidia fenestralis Serv.

Psinidia fenestralis is primarily an insect of sandy places and is commonly found only on sandy margins of streams or sandy fields, associated with the sand bur, *Cenchrus carolinianus*. The wing coloration varies from orange to light shades of coral-red and rarely specimens are taken with the colored area yellow. The flight differs from that of *Trimerotropis* in being low and direct, but is not as swift as in *Mestobregma*. The male has a faint aerial stridulation. The coloration of this insect is such that when on its normal habitat of almost clear sand, with scattered vegetation and a background of broken lights and shadows, its detection is almost impossible. We have often been unable to see the insects even when within a few inches of them, except by the movements or by the shadows they cast. The species occurs throughout eastern Iowa in sandy localities, but has as yet been taken only in the southeastern part of Minnesota, along the Mississippi River at Red Wing, Lake City, and Winona.

TRIMEROTROPIS Stal.

Trimerotropis is medium or large in size; the body compressed. The pronotum compressed before the middle and narrower anteriorly than behind, its median carina low, especially on the metazona and broken before the middle by two wide notches; lateral carinae rounded and indistinct. Head slightly exceeding the prozona in width; vertex longer than broad with lateral carinae distinct, gradually converging, and continuous with the sides of the frontal costa, which is strongly sulcate, at least below; median carinae of vertex faint or obsolescent; foveolae small and shallow but distinct and triangular. Tegmina longer than the abdomen in both sexes; wings with the basal area yellow, outwardly bounded by a curved black or fuscous band. The genus reaches its greatest development in the West and we have within our borders but two species, which may be separated by the following characters:

Tegmina minutely maculate, the spots not aggregated into groups or bands extending across the surface; frontal costa sulcate as strongly below as above the ocellus; hind tibiae yellow *maritima*
 Tegmina fasciate usually with solid and well-defined bands; frontal costa sulcate above the ocellus for a short distance only; hind tibiae red or orange *citrina*

Trimerotropis maritima Harr.

Trimerotropis maritima is very distinctly a lover of open, sandy areas and occurs in some abundance on the sandy flats of the Mississippi and other streams in the southeastern part of the State. It is

an especially well-marked example of protective coloration, matching almost exactly the varied background which it frequents. This, together with its alertness and activity, renders it very difficult to capture. The only way in which we have commonly been able to take it was to "mark down" as it alighted and then rush it once or twice, relying upon catching it by sweeping it up as it arose. It delights in the open sunshine and we have watched it walking aimlessly about upon the sand for long periods without any attempt at feeding, apparently merely enjoying the warmth. When we approached unduly near, it would crouch close to the sand prepared for flight but seemingly aware of its protecting coloration and not arising until some unusual or rapid movement alarmed it. Its flight is very strong and it can, and does at times, cover unusual distances for an *Oedipod*.

Trimerotropis citrina Scudd.

Trimerotropis citrina is closely related to the preceding species but distinguishable by the sulcation of the frontal costa and the red posterior tibiae. This species is found through the same area within our borders as the preceding, though doubtless both are more widely spread through the State. We have repeatedly observed females of this species ovipositing in loose sand along streams. The female selects a suitable location, using the greatest deliberation, frequently beginning the hole only to abandon it shortly for another, more acceptable site. The spots finally chosen are usually at the base of some plant, such as a tuft of *Triodia purpurea*, *Sporobolus longifolia*, or other grass. After the hole has been completed, the female usually withdraws the abdomen and pauses a short time, apparently resting. She then backs down into the hole and working the abdomen to the bottom begins oviposition, which continues for some time with considerable evidence of muscular exertion. In one case we watched the preliminary stages and remained for about ten minutes after oviposition had apparently begun. We then marked the spot intending to dig up the mass later but upon our return over half an hour later the female was still engaged in oviposition. Upon digging up the mass we found an incomplete pod with 17 eggs. In many cases the females oviposit far out on open sand bars during the low water of late summer and these eggs must of necessity be swept away by the moving of the sand during spring floods. It appears evident that there must be great loss of eggs through such faulty selection of locations. From field observations, partly confirmed by caged specimens, it is probable that the females sometimes, possibly often, oviposit more than once during the season. We have seen specimens of this insect from Winona, Gray Cloud Island, and Mahtomedi.

CIRCOTETTIX Scudd.

Circotettix varies from medium to rather large in size, with the body somewhat compressed and the eyes prominent; disk of vertex much longer than broad, abruptly narrowed before the eyes, thence continued without further narrowing into the frontal costa. Pronotum relatively short, truncate at anterior margin and rectangulate at posterior margin; its median carina distinct and twice cut before the middle; lateral lobes deeper than broad, the front margin straight, the posterior more or less concave. Tegmina rather broad and longer than the abdomen in both sexes; wings pale yellow in basal area, outwardly bounded by a dark curved band beyond which at the apical angles they are nebulous or transparent; three or more of the radial veins incrassate. Coloration and form suggest *Dissosteira* rather than *Spharagemon* as has been stated by some authors. We have but one species which is, however, rather variable in coloration.

Circotettix verruculatus Kirby

Circotettix verruculatus is a rather common insect through the northern and eastern parts of the State. While it often much resembles *Dissosteira*, not only in appearance but in habits, it may readily be separated from this by the yellow coloration of the wings and the flat dorsum of the pronotum. Its resemblance to dark forms of *Spharagemon* has also been noted but here another character readily serves to distinguish it, since in *Spharagemon* the median carina of the pronotum is cut by but one sulcus, while in *Circotettix* there are two well-marked notches. It is primarily an insect of dry or even dusty places and is somewhat saxicolous, loving rocky exposures. On the granite hills about Lake Vermillion it occurs in countless numbers and on a bright day the stridulation of the males in flight fills the air. The flight of this species is the strongest and longest of all our Oedipods, possibly excepting *Trimerotropis*, and is very indirect in its course, often completely circling about the observer and ending near the point from which it started.

While, as stated, this insect is fond of dry places, it may also be taken amid the blackened logs of burnt-over areas in the forest or even in the dense tangle of a tamarack swamp. It has been stated that the forms from such burnt-over areas are dark, while those of more open places are lighter, but examination of material in the field at Ten Strike, Vermillion Lake, and other points does not support this so far as Minnesota is concerned. For instance, from an open, rocky place we took twenty specimens; twelve of these were blackish, five brownish, and three neutral in tint. From an area in the woods,

burnt over and covered with a tangle of blackened logs and stumps, we took twenty more: of these fifteen were blackish, three brownish, and two neutral, thus showing practically the same relative proportions. We have noted the same intermingling of forms along the shore of Lake Superior, near Duluth, but in our area the black apparently always outnumbers the others.

The aerial stridulation of the males is a sharp crackling, very like that of the *Arphias* but much louder and more continuous. We once noted an interesting performance by three males at Biwabik. Out in the center of the railway switch yards, these three were grouped closely together and so intent were they that we were able to approach within a few feet without alarming them. First one would raise both hind femora high up and with a quick jerky movement rub them vigorously against the sides of the tegmina; after a time he would pause and stand at attention while one of his mates took up the performance. To our ear no "music" was audible save a faint grating noise, far from melodious. This performance was repeated time after time and we do not know how long it might have continued had they not been interrupted by a heavily loaded ore train. As to the object of such demonstration, we have no explanation to offer since there were no females within a rod or more.

In Tower and some of the other northern towns, this usually shy insect takes the place of *Dissosteira* in the streets and appears as thoroughly at home there as the "Carolina locust" in the southern cities. At Tower we have noted that while it is abundant on the streets during the warmer part of the day, it disappears by about five o'clock in the afternoon and upon search we found it on weeds, posts, and other somewhat elevated places, apparently having retired for the night. It remained thus until rather late in the morning, not becoming active until nearly nine o'clock. While thus at rest, the insect is very sluggish and does not start readily, making it easy to take such as may be desired. In the habit of poising motionless in the air, this insect also resembles *Dissosteira* and may be seen at times suspending itself in the air, much more like a butterfly in appearance than a locust. In northern Minnesota, this species matures about the first of July and may be found until killing frosts. We have taken it at Bemidji, Blackduck, Hibbing, Biwabik, Virginia, Vermillion Lake, Duluth, Taylor's Falls, and Hinckley. It will probably be found throughout the area of the coniferous forests of our State.

SUBFAMILY ACRIDINAE

The members of the subfamily *Acridinae* may be readily distinguished by the presence of a distinct spine, usually conical or cylindri-

cal, projecting from the prosternum between the front legs. The face is vertical or nearly so in all save the first genus. The head is relatively smaller and less swollen than in either the *Tryxalinae* or the *Oedipodinae*. The disk of the vertex is not sunken or concave, its lateral carinae are low and rounded or often obsolete; foveolae are commonly wanting or indistinct. The disk of the pronotum is normally flat or nearly so and is never strongly tuberculate or rugose; its posterior margin is never acute-angled but usually rounded or subangulate. The antennae are relatively short and composed of from twelve to twenty-five joints. Tegmina may or may not be present and, when present, vary from the length of the pronotum or less to forms longer than the abdomen. The inner wings, when present, are transparent, usually vitreous, and never brightly colored. The posterior femora are well developed and the members of this group are in general strongly saltatorial.

This subfamily includes most of the species which are of economic importance within our area and indeed throughout the world, the truly destructive locusts, save for certain *Tryxalinae*. It includes nearly all of the truly migratory species together with a very large number of species which, while non-migratory, are at times extremely destructive to growing crops. The enormous damage resulting from the invasions of the Rocky Mountain locust, *Melanoplus spretus*, causing losses at one time placed at over \$200,000,000 in the Middle West, is an example of the economic importance of one of the migratory species, while the annual loss from our non-migratory species, although it can not be accurately estimated, since, being yearly, our crop returns are adjusted to it, would be equally startling if it could be expressed in dollars. It is safe to say that if we could but eliminate these established and unnoticed pests for one year, the crop returns would be enormously increased. In this group the "music" or stridulation of the males appears to be confined to the one method of rubbing the hind femora against the edge of the tegmina. This is, of course, weak "music" as compared with the loud calls of some of the *Locustidae*, but even in the case of certain brachypterous forms, the males have been seen to go through the motions although no sound was audible to the listener. Some of the species of *Schistocerca* produce a faint rustling sound with the wings when in flight but there is nothing approaching the definite and controlled aerial stridulation of some of the members of the *Oedipodinae*. In general the coloration of the members of the subfamily is of varying shades of dull brown, although a few are rather strongly colored. Classification of this group is based in large part upon the ventral sclerites and the genitalia of the males. The following key will serve to separate the genera of this subfamily which are represented in Minnesota:

- Face very oblique with fastigium of vertex acute *Pseudopomala*
 Face vertical or nearly so, the fastigium of vertex never acute
 Mesosternal lobes longer than broad, the inner margin straight; insects of large size *Schistocerca*
 Mesosternal lobes transverse, or length equal to breadth; the inner margin rounded
Melanopli
 Lateral margin of subgenital plate of male, viewed laterally, straight throughout or but slightly convex, never ampliate at base; furcula of male composed of projecting cylindrical fingers *Hypochlora*
 Lateral margin of subgenital plate of male, viewed laterally, convex or sinuate, decidedly ampliate at base
 Subgenital plate of male with a distinct subapical tubercle, but not otherwise tumescent; body relatively slender and compressed *Hesperotettix*
 Subgenital of male with no distinct subapical tubercle but often apically prolonged or tumescent
 Interval between mesosternal lobes of male distinctly transverse; metasternal lobes of male generally distant or sometimes almost approximate; face slightly oblique *Podisma*
 Interval between mesosternal lobes of male generally longer or much longer than broad; metasternal lobes of male generally attingent or subattingent
 Head not enlarged or prominent and but little longer than the prozona, save when the latter is transverse; intercalary veins relatively numerous; cerci of male (in our species) never styliform *Melanoplus*
 Head large in proportion to pronotum and nearly half as long again as the long prozona; intercalary veins few and not well marked; cerci of male styliform; subgenital very narrow *Phoetaliotes*

PSEUDOPOMALA Morse

Vertex horizontal, longer than broad, semi-elliptical, convex, and with a very distinct median carina, laterally sulcate in female, or extended into laminae in the male, with the margins limited by the lateral carinae. Lateral foveolae are wanting, frontal costa sulcate throughout with heavy, slightly divergent, lateral carinae except at the apex, where it is much constricted. The face is nearly straight and very declivent. The antennae are slightly triquetrous and much flattened and expanded basally, where they about equal in breadth the short diameter of the eye. In the female they are as long as the head and pronotum and in the male considerably longer than this. Pronotum slightly longer than the head; the disk nearly plain though slightly elevated toward the median carina which is distinct and cut once, far behind the middle, by the principal sulcus, which is visible, although faint on the disk. The lateral carinae are distinct, parallel, or slightly narrowed posteriorly, and normally cut by the principal sulcus only, though sometimes in males the first sulcus, though faint, cuts the carinae. The posterior margin of the metazona is straight in females and very broadly rounded or nearly straight in males. The lateral lobes of the pronotum are vertical, slightly convex above, with the anterior and posterior margins strongly oblique, the anterior straight and the posterior sinuate just above the lower angle, which

is sharp and subrectangular. The inferior margin is straight and nearly horizontal. The mesosternal lobes are separated by a space somewhat longer than broad in the female and about as long as broad in the male. Wings are abortive in both sexes and the tegmina may be short or well developed. The posterior femora are slender and not distinctly banded; posterior tibiae have the inner apical spurs not very unequal. The last ventral segment of the male is horizontal, elongate, conical, and about four times as long as the penultimate. The ovipositor is moderately to strongly exerted. We have but one species in this genus, which from its peculiar structure has been variously placed in the *Tryxalinae* and the *Acridinae*.

Pseudopomala brachyptera Scudd.

Pseudopomala brachyptera is an odd-looking insect. As stated previously it presents characters of both the *Tryxalinae* and the *Acridinae*. The prosternal spine is distinctly and sharply conical, although small, but the general aspect is that of a Tryxalid. In color the species is brown, minutely dotted with black and obscurely striped with somewhat lighter shades. The female is more uniformly brown than the male. In general aspect this insect has much the appearance of a small brachypterous form of *Mermeria*. In Iowa adults have been taken from June 6 to late September, while immature forms (pupa or nymph) have been taken as late as July 10, thus suggesting a somewhat irregular breeding period. So far as our field experience goes, this species appears to be associated with certain tall grasses, notably *Andropogon scoparius* Michx. In Minnesota it has been taken at Pipestone, Brown Valley, and Gray Cloud Island, and careful collecting will doubtless discover it at other points in the southern part of the State.

SCHISTOCERCA Stal.

Size relatively large. Vertex with the front deflexed; fastigium not prolonged and apically obtuse; lateral foveolae minute or wanting; lateral carinae low and faint; median carina absent; face nearly vertical. Pronotum with the disk convex on the prozona and flattened on the metazona; the lateral carinae absent, the median low but distinct; posterior margin of the metazona rounded or subangulate. Lobes of the mesosternum longer than broad, with the inner margin straight, and strongly angulate at tip. Tegmina always well developed and longer than the abdomen in both sexes; wings vitreous. Hind tibiae having smooth margins with numerous spines regularly disposed on both sides but with no apical spine on the outer margin. Second joint

of posterior tarsi only about half as long as the first. Male cerci oblong and of nearly equal breadth throughout; subgenital plate strongly re-curved in male and with its apex deeply notched. Our species are all large or medium-sized insects of reddish coloration and are all capable of strong and well-sustained flight. They are in general more or less arboreal and for this reason are not commonly noted, although in some parts of the State two species at least are relatively numerous. Since these insects are at times more or less migratory, their exact range or area of distribution varies, and species, while plenty at a certain locality at a given time, may not appear there again for long periods. The following characteristics will serve to distinguish our species:

Antennae of males nearly or quite one-third (often one-half) longer than the head and pronotum together.

Pronotum not tectate, or but feebly so in females; no light-colored dorsal stripe; metazona rugulose *rubiginosa*

Pronotum always more or less distinctly tectate; a light-colored dorsal stripe always present; dorsum of metazona plane or nearly so in both sexes; hind tibiae not red *alutacea*

Antennae of males hardly more (often less) than one and one-fourth times as long as the head and pronotum together; large species, with male cerci tapering from base to apex *americana*

Schistocerca rubiginosa Harris

Schistocerca rubiginosa is closely similar in habits and structures to *S. alutacea* Harris and in fact, from our observations of this species in the field we are inclined to consider it rather a form of the latter than a true species. This belief is strengthened by the fact that there is, in the field, every possible intergradation between the two. The typical form with the flattened dorsum and with no light-colored dorsal stripe has been taken with *S. alutacea* at St. Paul Park, Mahtomedi, and Northfield, while Lugger (Third Ann. Rept. of Entomologist Minn. Exp. Sta. p. 174) has reported it indefinitely "from the wooded bluffs of the Mississippi River in the southeastern part of the State."

Schistocerca alutacea Harris

Schistocerca alutacea is the largest of our Orthoptera, except only its congener, *S. americana*, and is to be found in areas of dry soil, apparently most abundantly where there are scattered trees, as along the banks of streams. At Gray Cloud Island, Winona, and other points in southeastern Minnesota it was very abundant during the fall of 1912. It doubtless occurs throughout the southern part of the State in places offering its favored habitat. It is very active and easily alarmed and usually rises for rather long flights, frequently alighting amid the branches of trees or shrubs rather than on the ground. When in flight it makes a rustling sound, possibly comparable to the

aerial stridulation of some of the Oedipods, but much less audible. The species matures during July and is present until severe weather in the fall. In the southern states this species, together with the following, may be seen active throughout the winter. We have seen both in the woodlands of South Carolina, feeding and flying when alarmed even during January.

Schistocerca americana Dru.

We have not taken *Schistocerca americana* within our area as yet, although we have taken it at Rock Rapids, Estherville, and other points in the extreme northern part of Iowa and feel no doubt that it will be found at least occasionally in southern Minnesota. It is a fine large insect, more reddish in tint and more heavily maculate than either of the foregoing. It is very difficult to capture during the bright warm days of summer but in late autumn it becomes sluggish, feeding little and hanging motionless to the sides of buildings or other elevated places, evidently enjoying the warmth of the sun's rays and awaiting the end, although as just stated it and others of the genus remain active throughout the winter in the southern states. We have heard the children call this insect the "bird grasshopper" and truly, when seen in flight, its great expanse of wing makes this name very fitting. Scarcely less apt is the name "clickety bug" given it by the negroes in South Carolina, referring to the rustling of its wings in flight.

HYPOCHLORA Brunn.

Body rather slender, compressed, and sparingly pilose. Head not prominent, the summit gently arched, the fastigium moderately declivent; interspace between the eyes broad, frontal costa rather narrow, sulcate, percurrent, and subequal. Eyes not very prominent, similar in both sexes; antennae moderately stout and about as long as the head and pronotum. Pronotum subequal, very feebly and gradually enlarged posteriorly, with a distinct percurrent median carina; the disk very broadly subtectate with the lateral carinae not well marked. Lateral lobes of pronotum vertical. Front margin of prozona subtruncate, hind margin of metazona very obtusely angulate; the very coarsely, feebly, and sparsely punctate prozona half as long again as the very finely and suddenly punctate metazona, its posterior margin faintly angularly emarginate; one transverse sulcus dividing the disk into equal halves, and straight, the other a third of the distance behind this and sinuate. Prosternal spine erect, moderately slender, and conical. Mesosternal interspace much longer than broad in both sexes.

clepsydral in shape; metasternal lobes subattingent, especially in the male. Tegmina abbreviate, acuminate, attingent, or overlapping and about as long as the pronotum. Hind femora slender, somewhat compressed. Abdomen of male neither clavate nor curved upward apically; lateral margins of the subgenital straight from the base; subgenital acute-angulate at tip, with a slight, blunt, apical tubercle; cerci very simple, slender and apically incurved; furcula consisting of a pair of slight, cylindrical, slender fingers, parallel, subparallel, or somewhat approaching one another posteriorly. This western genus is, as now defined, monotypic.

Hypochlora alba Dodge

Hypochlora alba is a small, rather pale green insect having considerable general resemblance to *Melanoplus gracilis*. We have taken this species at several points in western Minnesota, notably at Pipestone, Granite Falls, and Fergus Falls, in all of which cases it was associated with the wild sage (*Artemisia cana* Pursh. and *A. ludoviciana* Nutt.), an association which has been previously noted by Bruner. Speaking of this insect he says, "Here in Nebraska it is one of the commonest species . . . it is most commonly found on *Artemisia ludoviciana*." In Iowa and doubtless in the southeastern part of Minnesota, it finds equally good concealment on *Froelichia* and the hoary species of *Oenothera*. It matures late in July.

HESPEROTETTIX Scudd.

The sides of the body of *Hesperotettix* are almost parallel and are somewhat compressed and not much enlarged at the metathorax. Head not very prominent; vertex usually very narrow between the eyes; frontal costa generally as broad as, if not broader than, this interval between the eyes and sulcate throughout. Front straight, somewhat oblique; antennae longer than the head and pronotum together; eyes slightly prominent, more distinctly so in the male. Pronotum long and slender, the dorsum fully half as long again as broad; the prozona considerably longer than the metazona, sometimes half as long again, and with less distinction in surface and sculpture between them than usual, both broadly tectiform; the median carina slight but distinct and alike or nearly so throughout. Posterior margin of the disk with a very obtusely angulate tip and the border delicately margined. Prosternal spine rather long and bluntly conical; mesosternal interspace generally twice as long as broad in male, and nearly subquadrate in the female; metasternal lobes subattingent in both sexes. Tegmina and wings

present and in our species well developed and at least as long as the abdomen. Hind femora long and slender, somewhat compressed, generally surpassing the abdomen, the superior carina slight and unarmed; first joint of hind tarsi scarcely longer than the third.

The species are, in general, very closely allied and at times forms are taken which are not readily placed. The genus is closely related to *Hypochlora*, but may be distinguished by the ampliation of the base of the subgenital of the males. The species are small, trim insects, of green color and having much the aspect of *Melanoplus*. Two species are known in Minnesota and a third, which has been doubtfully reported from our State, may yet be definitely established and is here included to aid in identification.

Metazona never rugulose, sometimes feebly punctulate

Transverse sulci of pronotum marked in black

Transverse sulci of pronotum not marked in black or contrasting colors;

dorsum tectiform

Metazona distinctly rugulose; dorsum tectiform

viridis

pratensis

speciosus

Hesperotettix viridis Thom.

Hesperotettix viridis appears to have been frequently confused with others of the genus. It has been reported from Minnesota by Bruner, but Scudder (Revision of American Melanopli, Proc. U. S. Natl. Museum, Vol. XX, p. 58) considers this doubtful. Since it does occur in Nebraska and in Iowa, it may yet be positively fixed as a member of our fauna and is here included to aid in recognition.

Hesperotettix pratensis Scudd.

Hesperotettix pratensis, which is possibly the most beautiful of our Acridinae, deserves a complete description, although the illustration (Plate I, 7) is as nearly perfect as may be desired. The head is green, tingeing to yellowish green in some specimens, punctate with fuscous in front, the lower portion of the face more or less purplish; a short fuscous bar descends from the eye in both sexes; vertex with a rather narrow fuscous stripe, sometimes blackish anteriorly, extending back, ordinarily with a median thread of yellow; the fastigium generally discolored and, especially in case of the females, reddish. The pronotum slightly increasing in breadth posteriorly and with no angle at the middle, yellowish green in some specimens (Minnesota) with a very faintly defined, light-colored line along the lateral carinae and extended upon the head, where it follows the upper posterior margin of the eyes; above the middle of the lateral lobes of the prozona is a more or less distinct fuscous, often irregular bar, generally darker below and somewhat margined above and below with whit-

ish; usually a distinct and sometimes conspicuous stripe along the median carina, frequently, especially in males, bordered by a reddish area widening posteriorly. Tegmina well developed in both sexes, being as long as, or slightly longer than, the abdomen, light green, often more or less suffused with reddish pink. Legs green, the fore and middle femora with a more or less distinct annulation of pink above the geniculation; posterior femora slender, somewhat fuscous, most noticeably so in females, and with a more or less distinct reddish annulation before the tip. Hind tibiae pale bluish green, sometimes yellowish apically, the spines bluish at base and blackish at tip. Supra-anal plate triangular, obtuse at tip, length about equal to breadth, the margins nearly straight; furcula minute, rounded lobes rather widely separated; cerci considerably shorter than the supra-anal plate, simple and regularly conical on basal half, the apical half subequal, bluntly pointed, feebly curved downward; last dorsal plate broadly rounded and rather deeply emarginate. The following measurements are from specimens now before us: male, length 18.5 mm., tegmina 13 mm., hind femur 11.5 mm.; female, length 24.5 mm., tegmina 19.5 mm., hind femur 15.5 mm.

We have taken this insect at Pipestone, Redwood Falls, Fergus Falls, and Albert Lea. It is usually found on dry prairies more or less rolling and of sandy or gravelly soil. In most cases it has been found associated with *Melanoplus angustipennis*. At Fergus Falls, where we noted adults of both sexes on July 14, it was not commonly found in the weeds or low grasses but in tufts of *Symphoricarpus* or amid tall Compositae.

Hesperotettix speciosus Scudd.

Hesperotettix speciosus is somewhat larger than *H. pratensis*, with the disk of the pronotum usually distinctly rugulose, the rugae usually yellowish and having a more or less transverse, never longitudinal direction on the prozona, while upon the metazona they usually extend longitudinally; tegmina more yellowish than in the preceding and with the veins yellow, shorter than in *H. pratensis*, and often rather abbreviate, especially in the male. Hind femora green more or less suffused with roseate. Supra-anal plate of male triangular and usually acute or subacute at tip; furcula of short triangular lobes; cerci delicate, slender, conical, with the outer half distinctly incurved. The records of this species in Minnesota are based upon a pair taken by us *in coitu* at Mahtomedi, July 29, 1909. They were found in dry open woodland with sandy soil. In Iowa we have taken it in some numbers on dry sandy soil in Muscatine County, associated with such plants as *Cenchrus carolina*, *Paspalum ciliatifolium*, and *Helianthus*

occidentalis. The measurements here given are from the Minnesota specimens above cited. Male, length 22 mm., tegmina 11 mm., hind femur 14 mm.; female, length 32.5 mm., tegmina 17.5 mm., hind femur 19 mm.

PODISMA Latr.

General form of head and body very similar to *Melanoplus*; antennae usually rather short; pronotum variable but always short and usually subcylindrical, though sometimes, especially in the females, expanded posteriorly, never contracted at the middle, generally with very feeble transverse sulci; front margin truncate, hind margin truncate, subtruncate, or even emarginate; prozona generally considerably longer than, sometimes twice as long as, the metazona, very faintly punctate; metazona generally densely punctate; median carina generally present though slight on the metazona and often more feeble or obsolete on the prozona. Prosternal spine always distinct, usually prominent, generally conical and blunt. Mesosternal interlobes of the male distinctly transverse, usually even more strongly so in the females; metasternal interlobes of male usually distant, rarely approximate, never attinent; in the female they are usually even more widely separated. Tegmina wanting, in our species, or short and lateral. Hind femora rather long and slender; spines of hind tibiae 9 to 11 (rarely 8) in outer series. Abdomen more or less distinctly compressed, in the male more or less clavate and recurved; cerci variable, often styliform; furcula feebly developed, if present at all; ovipositor of female variable, typically it is exerted, sometimes exceptionally extended, or sometimes partially withdrawn in the then obtusely terminating abdomen; cerci of female rather strongly developed and styliform.

The limitations between this genus and some of the genus *Melanoplus* are not great and while in typical forms the distinction can be readily made, yet in some forms they approach very closely. The genus is more widely, though sparsely, distributed than any other genus of the *Melanopli*, and is of a distinctly boreal type encircling the globe in its range. In America they have heretofore been known only from two widely separated regions, the Rocky Mountains in the West and from Ontario to New York and Maine in the East. We have recently found one species in St. Louis County, in the northeastern part of this State.

Podisma variegata Scudd.

The males of *Podisma variegata* are pallid-testaceous with an

olivaceous tinge, variegated with dark fuscous or brown, pilose; the females more distinctly olive or in life a lighter tone of green. Post-ocular band strong and broad, extending the whole length of the lateral lobes of the pronotum; median carina slight but distinct in both sexes. Pronotum distinctly compressed in male and cylindric-sub-sellate in the female. Tegmina are entirely wanting in both sexes. Hind femora flavo-testaceous, distinctly trifasciate; hind tibiae greenish. Abdomen distinctly compressed in both sexes and with a distinct dorsal carina, in the male clavate and somewhat recurved; sub-genital small with apex tumid; supra-anal triangular with a subrectangular apex; furcula consisting of a pair of approximate, short, tapering, black spines, hardly longer than the last dorsal segment; cerci castaneous, black-tipped, suberect, long, slender, tapering in the basal half and subequal beyond, the apical portion less than half as wide as the extreme base. Our specimens include immature males and one mature female. The measurements of the female are: length 23.5 mm., hind femora 11.25 mm., antennae 10.5 mm. As stated above we have taken this only in St. Louis County, where we found it on such shrubs as *Cornus* and *Rubus*, July 29, 1912.

MELANOPLUS Stal.

Melanoplus includes insects of medium or large size, some species, however, quite small, moderately stout, generally somewhat compressed, more or less, but generally feebly pilose. Head moderately or not at all prominent, generally little if any longer than the prozona, unless the latter, as rarely, is transverse; face almost vertical or in some cases slightly oblique. The vertex is gently tumid; eyes rounded and oval but not markedly elongate; fastigium more or less declivent, passing almost insensibly into the frontal costa, always more or less sulcate, with elevated lateral margins, generally more strongly so in the male than in the female; the antennae slender or moderately stout, variable in length but never very short, never longer than the hind femora, and rarely, if ever, more than twice as long as the pronotum. Pronotum generally compressed to a greater or less degree, length rarely or never twice as great as average breadth; metazona generally more or less flaring, its disk plane and densely punctured, while that of the prozona is generally slightly convex and rarely flaring anteriorly, or if so but slightly, at most slightly punctate, and generally longer than the metazona; hind margin of pronotum obtuse-angulate or sometimes truncate; median carina generally faint or obsolescent on prozona and always distinct on metazona; lateral carinae are normally obsolete although often indicated by a distinct, though rounded, shoul-

der. Lateral lobes vertical or nearly so, often feebly tumid on the prozona, especially above, and marked with a piceous post-ocular band, crossing the prozona or the whole pronotum, frequently broken or maculate. Prosternal spine variable but always prominent; mesosternal interspace generally much longer than broad; rarely transverse, but never broader than long; metasternal lobes generally attingent or sub-attingent. Tegmina always present but variable. When abbreviate they may be lateral, attingent, or overlapping, sometimes shorter or longer than the pronotum, but usually about the length of the pronotum and apically more or less acuminate. They may also be fully developed, when they equal, surpass, or fall a little short of the tips of the hind femora, and taper more or less, but very gradually, and are apically rounded. Hind femora moderately long and slender; hind tibiae with a variable number of spines (9 to 14) in the outer series, rare exceptions have but eight. Abdomen generally more or less compressed, the extremity in the male more or less, sometimes strongly, clavate, usually considerably recurved; subgenital plate of variable form but always with the lateral margins ampliate at base and with no distinct apical tubercle, though frequently apically produced or subtuberculate and frequently tumescent; the cerci exceedingly variable in form, often enlarged apically, nearly always lamellate, never styliform, generally incurved, and of about the length of the supra-anal plate; furcula usually developed, though quite variable in extent and form; ovipositor of female generally fully exerted.

This comprises the largest genus in the *Acridinae* and the one most widely distributed in North America, although it is apparently confined to this continent, where it is represented by approximately 150 species. These species are usually very similar in size and color and the differentiating characters are based largely upon the cerci, subgenital, supra-anal plates, and furcula of the males. In a few instances differentials have been worked out for the females but in general their classification can be best made upon comparison with accurately named material. Many species occur in both long-winged and short-winged forms and as there is in most species considerable variation of the cerci and furcula the classification of any large series of this genus presents an extremely difficult problem. Possibly because of this fact "new species" have multiplied and the records of many species have been so confused that the range of species is in some cases almost hopelessly clouded. To the writer, from observations in the field, it appears clear that in some cases species have been based upon too scant material or upon a few specimens from the extreme forms of variant species. The following key, which is based upon Scudder's Revision of the *Melanopli* (Proc. U. S. Natl. Museum, Vol. XX), modified somewhat in order to separate more easily Minnesota speci-

mens, will serve to distinguish the species occurring within our area:

- a Tegmina conspicuously shorter than the abdomen, often no longer than the pronotum; furcula usually feebly developed.
- b Cerci of male, beyond the middle, tapering or subequal, not expanded at tip and never styliform
- c Subgenital of male short and broad, its apical breadth equaling or even surpassing the length of its lateral margin; prozona longer than broad; furcula feebly developed *scudderi*
- cc Subgenital of male narrower than long, subpyramidal, broadly and roundly elevated at apex; furcula well developed *dawsoni*
- bb Cerci of male expanded apically, the tip at least broader than the middle, spatulate or subspatulate
- c Mesosternal interval of male quadrate or subquadrate; subgenital of male distinctly narrower than long; cerci of male stout *fasciatus*
- cc Mesosternal interval of male nearly (or sometimes more than) twice as long as broad
- d Subgenital plate of male short and broad, the apical breadth equaling or surpassing the length of the lateral margin; lobes of furcula longer than broad *blatchleyi*
- dd Subgenital plate of male distinctly narrower than long, often narrowing apically; furcula a pair of short, approximate, rounded lobules; posterior margin of pronotum distinctly emarginate in middle *gracilis*
- aa Tegmina nearly or quite as long as the abdomen, or even exceeding this; the furcula usually well developed
- b Cerci of male rapidly expanding from base to middle, short and not expanded apically; furcula of minute, triangular denticles *occidentalis*
- bb Cerci of male tapering from base toward middle, generally long and slender
- c Cerci of male, beyond the middle, either slender or tapering, never bifurcate at tip
- d Subgenital of male as broad as the marginal length or nearly so; its apical margin notched; cerci relatively broad, nearly equally so throughout; mesosternum of male with a central swelling anterior to the lobes
- e Tegmina extending behind the posterior femora by not more than the length of the pronotum; prozona of male quadrate or subquadrate; cerci of male usually nearly twice as long as broad *atlanis*
- cc Tegmina extending behind the posterior femora by the length of the pronotum or more; prozona of male strongly transverse; cerci of male not more than half as long again as broad *spretus*
- dd Subgenital of male variable but usually narrower than long, its apical margin entire; cerci usually long
- e Subgenital of male as broad, or nearly as broad, at apex as at base, generally elevated apically
- f Interval between mesosternal lobes of male longer than broad, much narrower than the lobes
- g Cerci of male very feebly incurved apically; subgenital of male relatively broad; hind tibiae red *dawsoni*
- gg Cerci of male strongly and abruptly incurved apically; subgenital of male relatively narrow, though short *gladstoni*
- ff Interval between the mesosternal lobes of male quadrate or even transverse and but little narrower than the lobes; cerci scarcely or not at all narrowed on apical half, far surpassing supra-anal plate; furcula minute *fasciatus*
- ce Subgenital of male conspicuously narrower at apex than at base, rarely elevated apically above lateral margins; never notched; cerci of male narrowed distally
- f Distal half of male cerci much less than half as broad as extreme base; mesosternal interval of male twice as long as broad; tegmina usually well developed *femur-rubrum*
- ff Distal half of male cerci distinctly more than half as broad as the extreme base; mesosternal interval of male scarcely, if at all, longer than broad; tegmina usually not attaining the tip of the

- hind femora *extremus*
- cc Cerci of male more or less expanded apically, broader at some point beyond the middle, spatulate, subspatulate, apically angulate or bifurcate
- d Cerci of male spatulate or subspatulate but neither angulate nor bifurcate
- e Furcula of male moderately developed
- f Hind tibiae red; furcula of male with straight subparallel forks *comptus*
- ff Hind tibiae glaucous
- g Furcula of male not more than one-third as long as supra-anal plate; cerci about three times as long as basal breadth; tegmina lightly maculate or immaculate *angustipennis*
- gg Furcula of male more than one-third as long as supra-anal plate; cerci shorter and stouter than in the preceding; tegmina usually heavily maculate *impiger*
- cc Furcula of male slight, the projecting portion not longer, or but slightly longer, than the last dorsal segment, upon which it rests
- f Forks of furcula conspicuously divergent; relatively large species
- g Prozona ordinarily with a dark median stripe, made more conspicuous by the much lighter color on either side, rarely plain light brownish testaceous; hind tibiae, in ours, usually blue *packardi*
- gg Prozona with uniform dingy coloration on the disk; the hind tibiae red *foedus*
- ff Forks of furcula nearly parallel; relatively small species, the tegmina maculate with fuscous spots *consersa*
- dd Cerci of male apically bifurcate or with an inferior process or angulation, or else so expanded as to be much broader apically than at extreme base
- e Small species
- f Lower fork of bifurcation of male cerci much longer than the upper *infantilis*
- ff Lower fork of male cerci much shorter than the upper, sometimes only an inferior process or angulation
- g Furcula of male distinct
- h Furcula consisting of slender spines, longer than last dorsal segment; cerci inferiorly angulate but not bifurcate *minor*
- hh Furcula consisting of short triangular lobes; cerci strongly bifurcate *luridus*
- gg Furcula of male absent; cerci strongly bifurcate *collinus*
- cc Large, or at least moderately large, species
- f Interval between mesosternal lobes of male twice, or more than twice, as long as broad; in female longer than broad; prosternal spine long
- g Furcula of male absent; cerci of male boot-shaped; hind tibiae yellow *differentialis*
- gg Furcula of male present, though small; cerci of male expanded at the upper margin but not boot-shaped; pronotum with two distinct light-colored lateral stripes on the disk, which extend back along the humeri of tegmina
- h Hind tibiae dark purplish basally, yellow or reddish apically *bivittatus*
- hh Hind tibiae clear red throughout *femoratus*
- ff Interval between mesosternal lobes of male subquadrate; of female transverse; prosternal spine short; insects of medium size, the tegmina maculate with rounded fuscous spots *punctulatus*

Melanoplus scudderi Uhl.

Melanoplus scudderi is a short-winged or brachypterous species, the tegmina being about as long as the pronotum, broad, ovate, and slightly overlapping. The general coloration is nearly uniform, dull, and brownish, often with a reddish tinge. The postocular dark bar

is not usually distinct or well marked. Riley has stated that the species attains maturity by September 1, at St. Louis, Missouri, but in Iowa we have taken adults in some numbers early in August and here in Minnesota by August 20, and have noted oviposition in the field by September 9. The species is fond of dry soil and in Minnesota, as also in Iowa, is most common in open woodlands. We have taken it at Albert Lea, Mahtomedi, Mankato, Redwood Falls, Florence, and Granite Falls.

Melanoplus dawsoni Scudd.

Melanoplus dawsoni is brighter in coloration but quite similar superficially to the preceding, although readily distinguished by the characters given in the key. This insect appears to have an irregular breeding period, since we have taken adults at Fergus Falls on June 21, while as late as July 25 nymphs and newly moulted adults were taken at the same locality. It is a much more common and widely distributed species within our area than *M. scudderi*, and appears to adapt itself to more varied conditions of habitat than any other of our brachypterous forms. In this State, as in Iowa, the short-winged form is the common one and the long-winged form rare. We have before us a specimen of the latter form, taken in August, at Fergus Falls, in which the tegmina are longer than the abdomen. It was taken in company with *M. luridus*, on gravelly hillsides along the Otter-tail River. This long-winged form has been given the varietal name *M. d. completus* Brun. As stated, this species is at home in widely varying habitats, but appears to be most abundant amid such brushy growths as *Symphoricarpos*, *Corylus*, and *Taxus*. It has been found throughout Minnesota and the following are but a few of the records that might be given: Pipestone, Albert Lea, Redwood Falls, St. Paul, Mahtomedi, Fergus Falls, Crookston, Bemidji, Blackduck, Lake Winnibigoshish, Grand Rapids, Vermillion Lake, Duluth, and Hinckley. The following from Mr. Howard's notes will be of interest here: "On July 15, nymphs in stages III, IV, and V, were taken near Fergus Falls, which moulted to adults by July 22. At Fergus Falls, adults were taken July 13, nymphs were also taken, and on July 25 nymphs in stages IV and V, were still numerous at Foxhome. By August 10 copulation was taking place in the breeding cages, and oviposition began by the middle of the month. Egg pods were of the usual *Melanoplus* type, and about three quarters of an inch long. Adults of this species were very abundant until September 1, at Fergus Falls, after which date they became more and more scarce until September 10, when they had practically disappeared, and after that date no further observations were made."

Melanoplus fasciatus Barnst. Walk.

Melanoplus fasciatus, like the preceding, is dimorphic, but so far as our records go the short-winged form, sometimes designated as *M. f. curtus*, is the only form as yet taken in Minnesota. In general coloration, this insect is of a dull grayish brown, tingeing to yellowish below. The postocular band is well marked and extends across the lateral lobes of the prozona. The tegmina, which are one and a half to two and a half times as long as the pronotum, are reddish or brownish, often somewhat maculate with darkish spots. Hind femora are dull yellowish with two rather well-marked, oblique, dark bars on the outer face, more distinct on the superior field; hind tibiae red, greenish, or bluish, with a rather distinct pale annulation near the base. In Minnesota this insect matures early in July and frequents rather low areas, either wooded, as tamarack swamps, cut-over areas covered with *Laccinium*, or open prairie among *Carices*. The male, which is darker in coloration than the female, is rather active when alarmed and leaps vigorously and erratically among the brushy growth, making capture very difficult. The species is in general northern in distribution. We have taken it at Fergus Falls, Warroad (Lake of the Woods), Bemidji, Lake Winnibigoshish, Hibbing, Vermillion Lake, Duluth, and St. Anthony Park. Since we have previously taken it in Iowa, it doubtless also occurs in the southern part of the State.

Melanoplus blatchleyi Scudd.

Melanoplus blatchleyi is the largest of our brachypterous forms and is of rather more than medium size. The general coloration is grayish brown above, shading to clay or yellowish below. Postocular bar usually present and distinct, though narrow in males, and frequently obscure or wanting in females. The pronotum is dark, though variably so; tegmina abbreviate, being a little longer than the pronotum, more or less overlapping, sub lanceolate in form and sometimes obscurely maculate. Hind femora testaceous, usually heavily and broadly fasciate with dark bars, often, especially in females, marked with two or three light spots near the base; hind tibiae red, more or less blackish at base, followed by an indistinct, pale annulus. On July 29, at Fort Dodge, Iowa, we observed a female of this species drilling in a piece of dead wood in very much the same way as *Chlocaltis conspersa*. At our approach she became alarmed and, attempting to escape, was secured as a specimen. Upon examination of the stick, it was found that there were two fresh holes drilled within a space of three inches. One of these was 8 mm. and the other 15 mm. deep. It would appear from this that some of our sylvan *Melanopli* may

acquire habits differing from the normal habits of the group. This species is in many ways the most adapted to woodland conditions of any of our *Acridinae*, except possibly *Chlocaltis conspersa*. It is commonly found in woodlands of high and dry soil, where it is usually associated with *Spharagemon bolli*. As Lugger has stated, it is especially fond of the wild grape, *Vitis*, of various species, upon which it commonly feeds. We have taken it, fully matured, at White Bear Lake as early as June 12.

Although doubtless common throughout the southern part of the State, we have records only of the following places for this species: Albert Lea, Worthington, Redwood Falls, St. Anthony Park, White Bear Lake, Gray Cloud Island, Hinckley, Detroit, Bemidji, Duluth, and Tower. We have not as yet taken it in the Red River Valley, although in some places the conditions appear right for this species and the forms commonly associated with it are to be found.

Melanoplus gracilis Brun.

Melanoplus gracilis is a rather small insect of greenish coloration, though sometimes brownish above; the hind legs bright green; postocular band broad, extending back across the lobes of the pronotum and percurrent, though sometimes slightly enfeebled on the metazona, bordered below by a light band. This is a sylvan species and apparently prefers such tangles of shrubby plants as a thicket of elder (*Sambucus*) undergrown with blackberry. From one such spot we took twelve of these pretty little insects within less than half an hour. The species matures about the middle of July or slightly earlier and continues until cold weather. We have often found it associated with the preceding species and with *Spharagemon bolli* but more commonly in the lower parts of woodlands, as along the margins of streams. We have taken this insect only at Red Wing, Mahtomedi, and Redwood Falls, but this scanty record does not, in all probability, represent its range within the State and it is probable that it will be found at many other points in the south and central parts of the State.

Melanoplus occidentalis Thom.

Melanoplus occidentalis is rather small, reddish brown, lighter below and at least dorsally rather strongly mottled with dark spots; postocular band rather brownish in color, continuous along the sides of the head but much fainter or absent on the lateral lobes of the pronotum, although there is frequently a more or less broken blackish patch on the upper portion of at least the prozona. The tegmina are brown with a slender, median, yellow stripe, and frequently maculate

with squarish dark spots. Hind femora variable in color; hind tibiae glaucous. The peculiarly expanded cerci, together with the minute furcula, should readily serve to distinguish this species, which has, as yet, been taken only from Ottertail County.

Melanoplus atlanis Riley

Melanoplus atlanis is extremely closely related to *M. spretus* Uhl., the formerly dreaded Rocky Mountain locust. It is one of the few species which ever become serious pests within our area. In size and general coloration (Plate III, 7), it is also very similar to our common or red-legged locust, *M. femur-rubrum*, from which species, however, it may be easily distinguished by the distinct apical notch in the subgenital of the male, while in *M. femur-rubrum* the subgenital is relatively broad with no notch at the apex. The differences which serve to separate this from *M. spretus*, however, are less distinct. The accompanying table will serve to show the close relationship of these three species.

From this table it may be seen that while it is easy to separate the males of *M. femur-rubrum* from the two related species by the differences in the cerci and subgenital plate, yet between *M. atlanis* and *M. spretus* the only structural differences which may be noted are extremely small and, in fact, easily within the limits of variation of a single species. Indeed the real differences are even less than the table would indicate, when local variations are considered, as the table is based upon descriptions from Scudder's Revision of the Melanopli (Proc. U. S. Natl. Museum, Vol. XX) and the measurements there given for *M. atlanis* are all admittedly of material in large part eastern, while in *M. spretus* all are western. Another fact worthy of notice is that in certain specimens taken in Minnesota and Iowa the characters blend. For instance, in certain specimens which we have examined, the measurements and the apical notch of the subgenital would indicate *M. atlanis*, but the tegmina surpass the hind femora by the length of the head and pronotum combined. In fact the real basis for separation seems to lie mainly in the extended migrations of one form, while in the other the migrations although occurring are of but local extent. For some years it has seemed to the writer that these two insects, *M. atlanis* Riley, and *M. spretus* Uhl., may be considered possibly as widely separated forms of a single variant species, the one being limited to the arid soils of the Rocky Mountains and their foothills, while the other is generally distributed throughout a large part of North America. Within this State *M. atlanis*, as already mentioned, has proved a pest of really serious importance at various times. It hatches normally about the middle or latter part of May and with

RELATIONSHIP OF MELANOPLUS SPRETUS, M. ATLANTIS, AND M. FEMUR-RUBRUM

Species	M. spretus	M. atlantis	M. femur-rubrum
Length, mm.....	Male 25.0	Male 21.5	Male 23.5
Tegmina, mm.....	Female 28	Female 24.00	Female 24.50
Hind femur, mm.	27	20.00	21.50
	14	12.75	14.25
Color	Variable; normally a light griseo-fuscous tinged with reddish	Variable; griseo-fuscous rather dark; often tinged with reddish	Variable; brownish-fuscous often more or less tinged with reddish
Male subgenital.....	Notched apically, the notch rather broad	Notched apically, the notch narrower	Not at all notched at apex but rather broadly rounded
Male cerci.....	Not over one and one-half times as long as broad; rounded apically	Almost or quite twice as long as broad; rounded apically	Longer, distinctly tapering from basal half; apically obliquely truncate
Prozona	Strongly transverse	Quadrate or very feebly transverse	Quadrate or feebly longitudinal
Mesosternum of male	With a central swelling in front of the lobes, forming a blunt tubercle		
Habits	Migratory	Submigratory	Non-migratory
Range	Rocky Mountains and Great Basin; east to Mississippi River	Most of United States and Canada	Most of North America

any series of favorable seasons becomes abundant, especially in the more open parts of the State. Large areas of wild hay land and other uncultivated tracts give sufficient undisturbed breeding-grounds to supply a source from which this pest must surely appear year after year until conditions shall be changed. The outlook in this as in several adjoining states is that so long as this and allied forms are allowed favorable conditions, there will continue to be danger of more or less serious outbreaks, meaning in every case great loss to the farmers of the area. Without entering into details of methods by which these insects may be controlled, we may say that a thorough system of cultivation of the land, with a rotation system in which a thoroughly cultivated crop shall always follow cereals, presents the real cure for these pests. Temporary means of relief and of reduction of numbers are to be found in the system of spraying with sodium arsenite, and in the use of hopper-dozers, when of proper design. These economic phases are more fully treated in the Fourteenth Report of the Minnesota State Entomologist for 1911 and 1912, to which reference should be made. The species is somewhat variable in the color of the hind tibiae and although these are commonly of varying shades of red, yet we have taken specimens with the hind tibiae yellowish, greenish, or rarely deep blue in color. Since the insect is generally and uniformly distributed over this and surrounding states no locality records are here included.

Melanoplus spretus Uhl.

Melanoplus spretus has been more widely and more carefully studied and has been the subject of more entomological thought and literature than any other Orthopteron. As the much-dreaded Rocky Mountain locust it has become known, by name at least, over a large part of the northern United States. It has been fully described and discussed in numerous publications, and since it is today apparently extinct, or practically so, no detailed description will be given here. We may say that this insect was never truly a native of our State and never persisted for any long period within our borders. It came at times, in countless millions, in its migrations from its breeding-grounds farther west, and the story of these grasshopper scourges of the early days, while now but a matter of history to many of us, are still vividly recalled by the older people, who suffered under those veritable plagues of locusts. It is hard today to realize the enormous numbers in which these voracious pests appeared and it is, perhaps, harder to grasp the full significance of what such an invasion meant to the scattered families of those early days, with their small fields and their woeful lack of means of communication and transportation.

When these great flights of "Colorado hoppers" as they were termed, first appeared the scattered populace was dazed and awed, while repeated visitations left them discouraged and actually destitute. The problem was too great for individuals or for states and the Federal Government appointed a special commission to study the pest and devise means of relief. Their work was carefully carried out and their reports are filled with data as to the life of the pest, its natural enemies, and the means by which man may control its abnormal increase, but the real solution of the problem came with the advance of civilization, more thorough and ever-increasing cultivation of large tracts in and near the natural breeding-grounds of the species, together



Fig. 10. Normal Habitat of *Melanoplus gladstoni* C. W. Howard

with climatic changes and changes of soil conditions which must follow the zone of cultivation. As stated above the species is now apparently extinct although specimens are sometimes taken which may be referred to this species by certain characters, but all which we have examined appear to be merely more or less aberrant forms of *M. atlanis*. There appears to be a rather general idea, frequently expressed by the older people, and especially by some of those who were settlers here when the Rocky Mountain locust swept this and adjoining states, that the pest so widely dreaded was of much larger size than, and of different appearance from, *M. atlanis*, which has proved a serious pest at various times within recent years. This opinion is, however, erroneous and to the student who wishes an idea as

to the appearance of the Rocky Mountain locust, we may say that, with a rather large and somewhat light-colored specimen of *M. atlantis* in hand, by extending the tegmina and wings somewhat in imagination, he may have a very good idea of the pest of the early days.

Melanoplus gladstoni Brun.

Melanoplus gladstoni (Plate I, 4) is of medium size and dark coloration; postocular band well marked and in ours continued back across the prozona on the lateral lobes of the pronotum. The tegmina are as long as the abdomen or slightly longer, and are rather slender, brownish, and distinctly, though not strongly, maculate. Hind femora are yellowish testaceous and marked by two distinct, oblique, dark bands and a basal blackish patch. Sometimes these markings are confluent, covering the whole lower field. Posterior tibiae red with an inconspicuous fuscous patellar spot. This insect matures about the middle of August, or somewhat earlier in favorable seasons and has commonly been taken on areas of dry or gravelly soil. At Fergus Falls in late summer it is one of the most common species on the hills along the Ottertail and Pelican rivers, in company with *M. luridus*. In life its bright coloration makes it especially attractive. We have taken it at Fergus Falls, Granite Falls, Brown Valley, and Pipestone. The following is taken from Mr. Howard's notes on this species: "Oviposition began August 29, in breeding-cages. The pods were placed in the moister parts of the rather clayey soil which was in the cages. The pods are not as solidly and compactly constructed as is usual with *Melanoplus*, otherwise it is about the same shape as is usual with this genus."

Melanoplus femur-rubrum DeG.

Melanoplus femur-rubrum is the common red-legged or garden locust and may be found practically anywhere within our borders. It is of medium size, though varying considerably; reddish brown, the pronotum usually lighter colored on the disk than on the lower parts of the lateral lobes; tegmina brownish to fuscous, more or less maculate; posterior femora olivaceous testaceous, variably infuscated, the lower field sometimes more or less reddish; posterior tibiae normally red, sometimes yellowish, or rarely greenish. Extremity of male abdomen strongly clavate, well recurved; furcula well developed, consisting of a pair of subparallel or sometimes slightly divergent fingers, tapering and subacuminate at tip; cerci roughly subfalciform, compressed and tapering rather rapidly from the base to middle and thence subequal to apex, where they are obliquely subtruncate, usually

somewhat incurved. Subgenital of male very short apically, the apical margin not elevated, strongly rounded, entire, broad.

This insect we have always with us and the fact that it has adapted itself to conditions in regions of the most careful and improved systems of cultivation makes it a form of real economic importance. While ordinarily no account is taken of the damage done by this species, because of the fact that it is always present, yet if we could but tabulate the damage it does the result would be truly startling. It prefers lowlands and at times may be seen by thousands on low fields, while on the hills near by it may be scarce or missing. It has a swift and well-sustained flight when alarmed. Fortunately this, like most species of this genus, is largely a creature of conditions and even when climatic conditions are favorable it is attacked by so many enemies and parasites that the naturally rapid increase is commonly kept within bounds. Like most of its near relatives, it oviposits late in summer and autumn and the eggs hatch in spring, usually during May. During a study of this species in the field for several years, considerable variation in most of the characteristic structures has been noted. In any large series, it will be noted that the cerci, furcula, and length of the tegmina vary considerably in development. After examining many thousands of this species within the past eight years, it appears that in abnormally dry seasons the tegmina are uniformly longer. Indeed, during the dry summers of 1910 and 1911, in the majority of specimens taken, it was noted that the tegmina exceeded the tip of the posterior femora considerably (Plate II, 8), and in many cases were fully as long, relatively, as in *M. atlantis*. Further, this tendency appears to be accompanied by an instinctive inclination for more extended flight and in such seasons this species, together with *M. atlantis*, makes more or less lengthy flights late in summer. The question arises, would a more prolonged series of dry seasons give a truly migratory form of these two species? If so, at least in the form *M. atlantis*, we should have an insect almost identical with the Rocky Mountain locust, *M. spretus*.

Melanoplus extremus Walker

Melanoplus extremus is of rather small or medium size, varying in coloration from dark brown to ferruginous, sometimes also of a greenish yellow tint; postocular bar extended back upon the lateral lobes of the prozona, which are usually lighter than the disk. The species is dimorphic in length of tegmina, but so far as known we have only the form *M. e. junius*, in which the tegmina do not attain the tip of the posterior femora. The long-winged form, *M. e. scandens*, may yet be taken in the extreme northeastern part of the State, since

there conditions of habitat are somewhat similar to those of localities where this form has been taken. While *M. extremus* was not noted as abundant during 1911, yet during the summer of 1912 its numbers were possibly equal to those of *M. femur-rubrum*, especially in the western part of the State. In our collecting throughout Iowa, we have taken this insect only in low areas, with plant forms such as *Eleocharis*, *Junci*, and *Typha*, but here in Minnesota we have found it in habitats varying from flat open prairie, with *Astragali* and *Koeleria*, to dry gravelly hills covered with such grasses as *Bouteloua* and *Sporobolus*, and at times even in the tamarack growths of the north. It is one of our earliest species and closely follows *M. minor*. At Fergus Falls it was taken June 14, and was observed *in coitu*, in the field, on June 24. We have taken this species at Redwood Falls, Hanley Falls, Wilkin County, Fergus Falls, Ada, Crookston, Warroad, Lake Winnibigoshish, and Karlstad.

Melanoplus comptus Scudd.

Since *Melanoplus comptus* was named upon material taken, in part, from our State, it is included here, although we have no other records of its occurrence. It is of small size, and brownish fuscous color. Head dull brown, somewhat luteous, more or less smoky and very faintly mottled. Vertex feebly tumid, only slightly elevated above the level of the pronotum; interspace between the eyes as broad as first antennal joint; fastigium strongly declivent, rather deeply sulcate throughout; frontal costa equal, as broad as the interspace between the eyes, shallowly sulcate at and below the ocellus, biserially punctured; eyes rather large and prominent, much longer than the infra-ocular portion of the genae; antennae fulvous, more than three fourths as long as the hind femora. Pronotum brownish-fuscous above, luteous-testaceous on lateral lobes, the latter marked above on the prozona by a dull, broad, piceous stripe, sometimes tinged with smoky olivaceous; disk scarcely expanding on the metazona, very broadly convex, and passing on to the inferiorly vertical lobes by a well-rounded shoulder, nowhere forming distinct lateral carinae; median carinae obsolete on the prozona; front margin transverse, almost imperceptibly emarginate in the middle, hind margin obtuse-angulate, the angle rounded; prozona subquadrate or feebly longitudinal, distinctly longer than the closely punctate metazona. The prosternal spine short conico-cylindrical, compressed, erect, very blunt; interspace between mesosternal lobes of male at least three times as long as broad, the metasternal lobes attinent for some distance. Tegmina brownish fuscous, immaculate or very feebly and obscurely maculate in the discoidal area, slender, subequal, scarcely expanded on the costa,

surpassing a little the hind femora; wings rather narrow, pellucid, glistening, the veins pale blue on the lower, fuscous or blackish on the upper half. Fore and middle femora but little tumid, luteo-testaceous, blotched with fuscous; hind femora luteo-ferruginous, obscured with fuscous above, and on the outer face above, interruptedly, so as to cause feeble signs of dusky fasciation, beneath chrome yellow, the genicular arc dull luteous, edged only with fuscous; hind tibiae red, narrowly pallid at extreme base, the spines black on apical half, ten to eleven in number in the outer series. Extremity of male abdomen a little clavate, somewhat upturned, the supra-anal plate long and triangular, the basal three-fifths with well-rounded, uptilted sides, beyond which the plate is laterally notched and contracted, the apex produced and very acute-angulate, the tip blunt, the median sulcus broad and not very deep, terminating with the basal portion; furcula consisting of a pair of depressed, uniformly tapering, acuminate, slightly divergent fingers less than a third as long as the supra-anal plate; cerci rather short and not very broad, regularly spatulate by the regular, slight, and gradual mesial contraction, the apical half rather strongly incurved, externally hollowed, the apex well rounded, not nearly reaching the tip of the supra-anal plate; infracercal plates well developed, laterally twice as broad as the cerci, well rounded, distinctly shorter than the supra-anal plate; subgenital plate scoop-shaped, but slightly angulate behind laterally, the apical margin scarcely elevated and most feebly notched. Length of body, male, 19 mm., tegmina 15.75 mm., antennae 9 mm., hind femora 11.25 mm. Described (Scudder, Revision of American Melanopli, Proc. U. S. Natl. Museum, Vol. XX, p. 302) from two males, one of which came from northern Minnesota and the other from Sydney, Nebraska. The species goes in the group with the following and doubtless will be found as rare and local.

Melanoplus angustipennis Dodge

Melanoplus angustipennis is an insect of medium size and rather dark coloration; the pronotum is dark fuscous but lighter on the lateral lobes with a subluteous median streak, bordering a broad piceous postocular band on the prozona; metazona with the hind margin distinctly obtuse-angulate. The hind tibiae vary from glaucous to bluish, apically feebly lutescent. Extremity of male abdomen somewhat clavate but scarcely recurved; cerci short and distinctly spatulate at tip; furcula consisting of a pair of slender, cylindric, rather strongly divergent, arcuate, regularly tapering, acuminate fingers not a third as long as the supra-anal plate. This insect is apparently almost entirely confined to areas of sandy soil and has, in most cases, been taken

upon beds of almost clear sand, among such tall grasses as *Sporobolus asper* (Mx.) Kunth, *Andropogon*, and *Chrysopogon*. Bruner states that the species feeds upon *Artemisia* and prefers to jump from plant to plant rather than to alight upon the ground. In Minnesota, as in Iowa, we have not found the species associated with the sage. There is in this species a slight superficial resemblance to *M. atlantis*, from the notched subgenital plate of the male, but the notch is here much weaker and the cerci and furcula entirely different from *atlantis*. We have taken this species at Mahtomedi and at Pipestone.

Melanoplus impiger Scudd.

Melanoplus impiger is very similar in appearance to *M. angustipennis*, although in ours usually rather smaller and more ferruginous in coloration and with the furcula longer and less divergent, the cerci smaller and less distinctly narrowed at the middle. The hind tibiae are glaucous to distinctly bluish and the subgenital plate of male very feebly or not at all notched at apex. Both species mature late in summer and are fond of sandy areas. This insect has, as yet, been taken only on sandy areas in the southeastern part of the State along the Mississippi River. It is in general southern in range and must be considered as having entered our State from that direction. It is, however, almost as rare in Iowa as within our State. Our records



Fig. 11. Normal Habitat of *Melanoplus packardii* C. W. Howard

show that this species has been found at Red Wing, Gray Cloud Island, and Fort Snelling.

Melanoplus packardi Scudd.

Melanoplus packardi is very similar in general appearance and closely related to both *M. angustipennis* and *M. impiger* when in its typical form, though it is one of the most variable of the genus as to coloration and markings. The very short furcula and the short cerci which are but slightly narrowed at middle and are truncate at tip, together with the longitudinally barred pronotum will usually serve to distinguish this species. It is usually somewhat larger than either of the preceding and in some forms has a slight resemblance to *M. bivittatus*, from which, however, it can be readily distinguished by the different cerci and furcula. We have found it sparingly in dry sandy fields and along roadsides at Granite Falls, Foxhome, Fergus Falls, Hibbing, and Duluth.

Melanoplus fædus Scudd.

Melanoplus fædus is closely similar in structure to *M. packardi*, but has the hind tibiae red. It is about the size of *M. angustipennis* but is darker in color, and in general structure is apparently more closely related to *M. packardi*. We have taken this as yet only in marshes and lowlands in the northern part of the State. At Lake of the Woods we found it in considerable numbers and at Allen Junction, where we found it rather scarcer, we noted that when alarmed the insect dived from the tops of weeds where it was feeding and burrowed into the soft sphagnum.

Melanoplus conspersus Scudd.

One specimen taken at Mahtomedi is classed as *Melanoplus conspersus* with some doubt. It is rather below medium size and of brownish coloration, paler below. Postocular band is faintly indicated upon the head but does not extend back upon the lateral lobes of the pronotum, which are rich brown, somewhat paler at the bottom. The median carina of the pronotum is distinct, broken at the sulcus and strongly elevated, almost subcristiform on the metazona. The tegmina are as long as the abdomen but not quite attaining the tip of the hind femora, brownish and heavily maculate with small, squarish spots; hind femora are stout, griseo-fuscous, and with two rather broad, oblique, dark bars. The furcula is short and the forks are widely separated at base and shorter than the last dorsal plate; cerci rather short, subequal, slightly narrowed at the middle, the tips spatulate and dis-

tinctly incurved, apically rounded. This specimen (male) has the following measurements: length 21 mm., tegmina 14.5 mm., and hind femora 11.5 mm. It very closely resembles a specimen in the collection of the Iowa State College, at Ames, which was taken in north-western Iowa and identified by Dr. Scudder.

Melanoplus infantilis Scudd.

Melanoplus infantilis is easily the smallest of our *Melanopli*, and possibly excepting *M. puer* of the extreme southeastern states, the smallest of this group in America. It is of griseous coloration varying from the typical dark form to quite light; the head brownish, more or less maculate with dark spots; postocular band often rather obscure on the head but distinct on the lateral lobes of the prozona, often edged with yellow above. Tegmina exceeding the abdomen and in most cases exceeding the tip of posterior femora in both sexes, cinereous in color and distinctly maculate with fuscous; posterior femora straw-yellow below, dark brown above, often ferruginous, with a pair of conspicuous oblique pale bars at the middle and next the base; posterior tibiae glaucous, often with a pale area at base and sometimes with an obscure straw-yellow space near the tip. The following measurements are from a pair taken at Fergus Falls: Male, length 15 mm., tegmina 11.5 mm., hind femur 8 mm.; female, length 17.5 mm., tegmina 13 mm., hind femur 10 mm. Adults occur by July 15 at Fergus Falls. It occurs commonly on dry gravelly soil and amid the somewhat scattered and pale vegetation of such soils; its grayish color renders it very inconspicuous. Indeed, at both localities where we found it, it was discovered only by accident in "sweeping" the low plants. It appears to be fond of climbing tall weeds such as *Verbena stricta* Vent. and the *Oenotheras*. We have taken it only at Fergus Falls and Detroit.

Melanoplus minor Scudd.

Melanoplus minor is a small or medium-sized insect (Plate I, 10), readily distinguished from others of our area by the peculiarly angulate cerci of the male and the relatively small size. It is normally the earliest of our *Melanopli* to appear in spring, and as far north as Fergus Falls has been found mature in some numbers by June 8. The females are dimorphic in coloration of the hind tibiae, being found with these glaucous or of a pale red tint, then normally with a pale yellowish area basally; the males, however, are, in our specimens, nearly all of the "red-legged" type. Mating has been observed in the field as early as June 20 and the young appear in August, passing the winter in an advanced stage of development. In general appear-

ance this insect somewhat resembles *M. angustipennis* and related forms and is often found associated with those species. Blatchley speaks of the close resemblance of Indiana specimens to *M. atlantis* and *M. femur-rubrum*, doubtless referring to the red-legged form, but in any case it should be readily distinguished from these by the slender spinelike fingers of the furcula and the angulate cerci. In this State we have found it under varying conditions of habitat but always on dry soils; in Iowa, where it occurs throughout the state, its habits appear to vary locally. In eastern and southeastern Iowa it is found in sandy areas with such associates as *M. angustipennis* and *Arphia carinata*, while in western Iowa, at Onawa, Denison, and Council Bluffs, it was taken only in meadows and grassy areas, while one was taken at Cherokee, on the swampy margin of a small stream, associated with small Locustids. In Minnesota we have taken it throughout the valley of the Red River and at Pipestone, Redwood Falls, and Mahtomedi.

Melanoplus luridus Dodge

Rather small, brownish fuscous, often more or less ferruginous; postocular band rather narrow and usually brownish, darker on the prozona and not extended on the metazona. The cerci of the male are distinctly forked apically, the upper fork larger than the lower. This species is well shown on Plate III, 8, and as will be noted, is very similar in appearance to *M. femur-rubrum*, though averaging smaller. It occurs commonly in dry upland fields, frequently in high, open woods. It matures late in summer and we have taken it *in coitu* September 9. It appears to be rather local in occurrence and frequently, while in favored spots many could be taken, it was apparently absent from other similar spots in the neighborhood. We have taken this insect at Albert Lea, Pipestone, Redwood Falls, Fergus Falls, Detroit, St. Cloud, Mahtomedi, St. Anthony Park, and Red Wing.

While the species here mentioned is classed as *M. luridus*, we have intermingled with it specimens which should apparently come instead under *M. collinus* Scudd. The two species were separated by Scudder upon difference in the development of the furcula and a slight difference in the form of the forks of the cerci. We have before us specimens showing both of these forms, taken on the same date from high, sparsely wooded hills along Ottertail River at Fergus Falls. Details of both are shown in the plate above referred to and we can but consider both as forms of one species.

Melanoplus differentialis Uhl.

Melanoplus differentialis is the largest of our *Melanopli*, a heavy-

bodied insect, nearly uniformly testaceous or, as with us, more commonly a distinct yellowish, sometimes varying to greenish. No well-defined postocular band on the head and but faintly marked on the lateral lobes of the prozona by a series of black or brown spots and by the darkening of the sulci in that field. Tegmina are well developed, reaching the tip of the hind femora or in the male surpassing this. Hind femora stout, heavily marked with "fish-bone" pattern in black. Cerci of male very stout, laminate, boot-shaped with the toe usually darker in color. This large and clumsy insect is known throughout a large part of its range as the "lubberly locust," a name which is in places shared by the still more lubberly *Brachystola magna*. In distribution, we have taken this insect, as yet, only in the southern part of the State, its northern limit being apparently the valley of the Minnesota River. Wherever found it is usually one of the most abundant species and of considerable economic importance. It appears to prefer low grounds and especially such rank growth as ragweed (*Ambrosia*), bur marigold (*Bidens*), and the like, having, however, no serious prejudice against cultivated crops of all kinds. This species, together with *M. bivittatus*, a closely related species, seem to be the only locusts found far in from the margins of thoroughly worked lands such as corn fields. The eggs are deposited in loose soil or even sand, often in cultivated fields. In September we have noted great numbers, literally thousands, of the females drilling and ovipositing in an abandoned melon patch where the soil was a soft and very sandy loam. They were not under the vines, for the most part, but every spot of bare soil was occupied by one or more of the females.

This species is said to deposit the eggs under the bark of logs sometimes, but this certainly must be an abnormal place for oviposition, since repeated tests in the breeding-cages failed to get such results. A series of females apparently ready for oviposition was collected. Part of these were placed in cages with sandy soil and these deposited abundant egg pods, while the remainder which were placed in cages under exactly similar conditions save that the bottoms were of wood, did not make use of, or attempt to use, logs with variously loosened bark, which we had included, and all died within a few days without oviposition. Scudder has stated that the northern limitation of this species is latitude 43° north, but we have found it in great numbers at 45°.

Melanoplus bivittatus Say

Melanoplus bivittatus is nearly as large as the preceding and is perhaps the most serious grasshopper pest, economically considered, that now occurs within our borders. When a series of favorable years permits of rapid increase, it becomes very abundant and causes

great loss, especially in those parts of the State where the culture of cereals is the rule. It is too generally known as the two-striped locust to demand much description, but we may say briefly that it is a large locust with two light-colored dorsal stripes and a general coloration of fusco-testaceous, or occasionally a dark brownish or even drab tone. The furcula of the male is present though very short and its forks are indicated as broad triangular teeth projecting from the last dorsal segment and rather widely separated at the base; the cerci are very stout, large and broad, laminate, externally more or less convex, the basal half narrowing gently; beyond the middle rather abruptly expanding into two lobes, the upper much larger and nearly the length of the basal half of the cercus, while the lower is brief and triangular; subgenital rather narrow, subequal and at apex slightly elevated and somewhat prolonged. This species is common in all parts of the State and at times abnormally so. In Iowa this insect matures about June 10, and in Minnesota about a week later. Mating occurs here early in July and the earliest oviposition we have noted in the field was August 8. The female of this species, as in others of this genus, deposits egg masses more than once during the season. In cages we have taken three egg masses from the same female. The insect does not appear at all particular as to the kind of soil in which the eggs are placed, since it has been observed drilling and ovipositing in such varied places as hard packed roadbeds, sod, gravel, railway embankments, sandbars, stubble fields and soft soil far out in fields of corn or potatoes. The number of eggs per pod varies greatly as pods have been taken which contained from 39 to 82 eggs. The freshly moulted insects are often of a beautiful light green tint, with the light dorsal lines faintly indicated but the color soon darkens to normal. The nymphs are to be found in varying colors and, in fact, at times the individual nymphs vary in different instars.

Like most species of this genus this insect is subject to attacks from a large number of enemies, including not only insects and fungus diseases but also birds, mammals, reptiles, and even batrachians and these varied natural controls serve to reduce its numbers greatly. *M. femoratus* Burm. is identical with *M. bivittatus* in size, general appearance and form of cerci and furcula, but differs mainly in the fact that the posterior tibiae are red (Plate II, 5, 6, and 7). It can but be considered as a mere color form of this species by one observing the two in the field. It has no more basis for specific distinction than have two other color forms which we have occasionally taken—one in which the hind tibiae are clear yellow throughout, and the other having the hind tibiae entirely and almost uniformly dark rose purple. All of these color forms, including the one termed

femoratus, occur together through the northern part of the State, with typical *bivittatus*, and we have on many occasions observed specimens *in coitu*, in which the sexes had differently colored hind tibiae. The mere fact of sexual union, however, is not conclusive, since we have taken such differentiated forms as *Camnula pellucida* (male) and *Dissosteira carolina* (female), and also *Stenobothrus curtipennis* (male) and *Gomphocerus clepsydra* (female) *in coitu*. The typical or dark-legged form is more common in the southern and western parts of the State, while at points in the extreme northern part the red-legged is easily the dominant form.

As has been previously mentioned this species breeds in a variety of habitats, but the source of such great swarms as have sometimes afflicted the farmers of the western part of the State, lies in large tracts of uncultivated soil and especially in such areas as the so-called "reverted lands" of the Red River Valley, great tracts, once under cultivation but now and for a number of years past lying idle, the old stubble densely grown with weeds—a veritable locust paradise and a constant source of danger.

Melanoplus punctulatus Uhl.

Dark gray, much mottled with fuscous; head and face lighter, and similarly mottled; postocular bar commonly broken and indistinct, especially upon the lateral lobes of the pronotum, which are quite dark in coloration. Pronotum subequal, somewhat widened at the metazona, somewhat flaring in front to receive the head, varying from luteous-testaceous to brownish fuscous. The disk and sides of the metazona and the tegmina are heavily maculate with fuscous. Fore and middle femora flecked with fuscous, showing usually a tendency to form a triple belting; hind femora similarly marked, with the belts more distinctly and uniformly marked, the lower and inner field often red; hind tibiae dull red, with a postbasal, obscure, flavous annulus. Extremity of male abdomen scarcely clavate and but little upturned; the furcula wanting; cerci large and broad, the basal half oblong, the apical half expanded to double the width of the base, the upper part usually considerably more than the lower. The tegmina are well developed and usually surpass the hind femora. The only undoubted Minnesota specimens of this insect we have seen are those mentioned by Lugger as having come from Gray Cloud Island. We have taken it in Iowa, almost on the Minnesota line, in low thickets of willow, *Salix amygdaloides*, while in Nebraska, Bruner has found it in oak groves, and in Indiana, Blatchley says of it; " . . . in low wooded tracts along streams, where it may be noted resting on the trunks of

trees, three or four feet above the ground." Scudder is inclined to consider coniferous trees as its most normal habitation.

PHOETALIOTES Scudd.

Body rather elongate, slender, slightly compressed, very feebly pilose, including faintly the tegmina and legs. Head large, full, prominent, relatively elongate, nearly half as long again as the long prozona, the space behind the eyes fully half as long as the breadth of the eyes, the genae a little tumescent, the head, apart from the eyes, slightly broader than the pronotum; vertex prominent and well-arched, both longitudinally and transversely; face a little oblique; eyes rounded, broad, oval, moderately prominent, subtruncate anteriorly, moderately distant, somewhat farther apart than the greatest width of frontal costa; fastigium very faintly sulcate, almost plane; frontal costa prominent, markedly narrower above than below the ocellus; antennae slender, moderately long, but shorter than the hind femora, though fully twice as long as the pronotum. Pronotum of moderate length, faintly subsellate but otherwise equal, feebly flaring in front to receive the head; disk rounded, subtectate, with broadly rounded, very indistinct lateral carinae and a sharp, equal, and percurrent, median carina; prozona longitudinal, nearly half as long again as the metazona, with indistinct transverse sulci; front margin subtruncate, hind margin extremely obtuse-angulate. Prosternal spine rather large, erect, conical, and blunt. Mesosternal interspace much (male) or slightly (female) longer than broad; metasternal lobes attinent (male) or approximate (female). Tegmina either abbreviate, broad, lanceolate, attinent, slightly longer than the pronotum, or fully developed, surpassing the hind femora, rather broad and equal with well-rounded tip. Hind femora long and slender, the genicular lobes pallid, with a transverse, dusky basal stripe; hind tibiae glaucous or sometimes yellowish, with 11 to 13 spines in the outer series. Abdomen compressed, mesially carinate, apically clavate and recurved in the male, subgenital plate narrow and long, with the lateral margins ampliate at base, apical margin mesially pinched but not elevated, no subapical tubercle; furcula consisting of a pair of short, slender, widely separated teeth, nearly parallel; cerci compressed, styliform, and rather small. A monotypic, though dimorphic, genus, very similar and closely related to *Melanoplus*.

Phoetaliotes nebrascensis Thom.

Phoetaliotes nebrascensis has, as yet, been taken in Minnesota only in the short-winged form, *P. n. nebrascensis*. The long-winged

form, to which the varietal name *P. n. volucris* has been applied, may yet be found within our borders since it occurs in Nebraska. The species may readily be recognized by the generic characters and by reference to Plate I, 9. It is an active insect and has been found under widely varying ecological conditions. The following notes, made in Iowa, are of interest in this connection. "It appears at first glance very much like some of the brachypterous forms of *Melanoplus*, but the compressed body and prominent head serve to separate it even in the field. We first took it at Fort Dodge in sweeping tall grasses, in an upland meadow; a more careful examination of the vegetation resulted in the discovery of numerous specimens, crouching among the stems and dead leaves at the bases of the plants. At Eddyville and Bayfield it was found among *Carices* and *Junci* along streams, while at Onawa it was taken among the *Sagittariae* in the margin of a pond." Exactly similar conditions and variations have been noted in Minnesota, and we have taken it here in low marshes, along lakes, and at the tops of high gravelly hills sparsely covered with grasses and weeds. We have taken this species at Pipestone, Mankato, Fergus Falls, Detroit, Wadena, and Mahtomedi.

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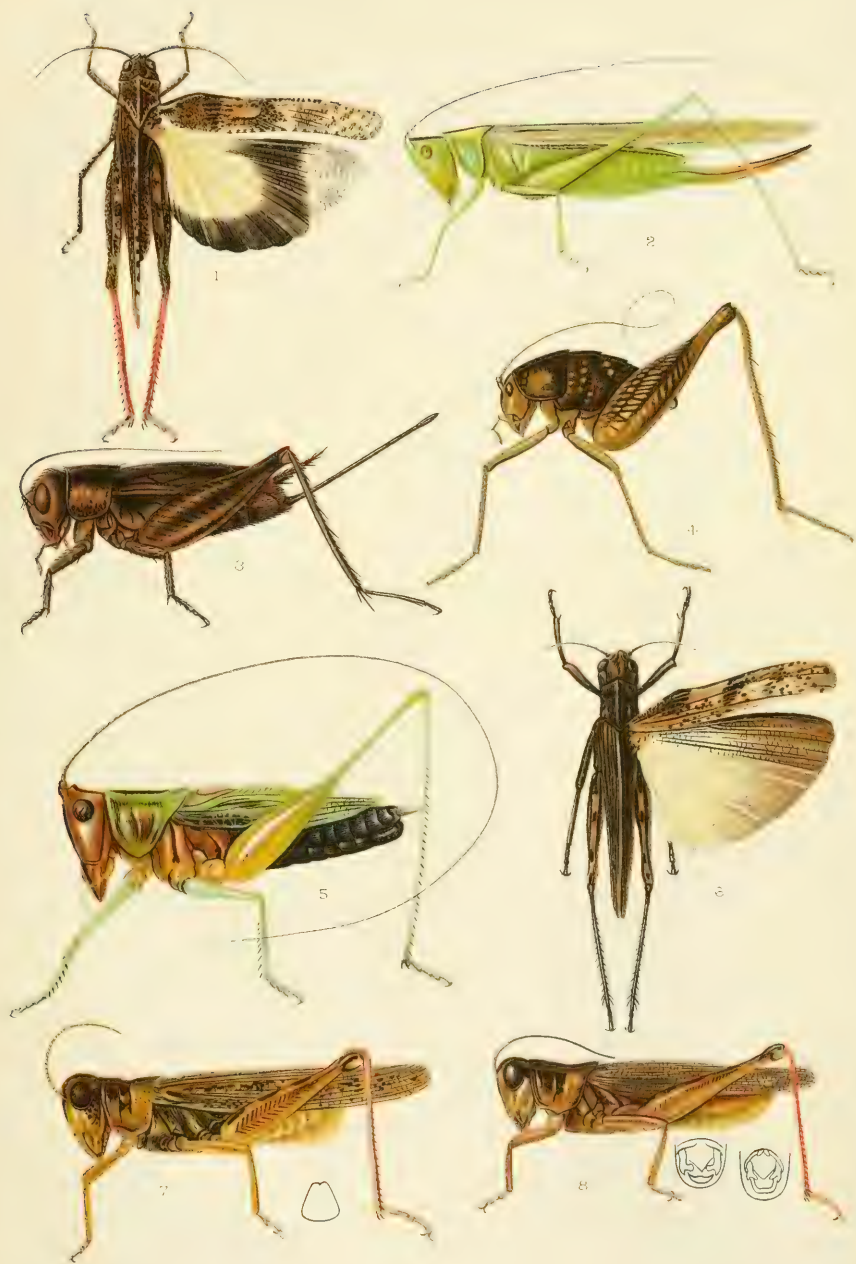


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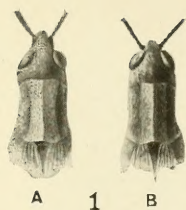




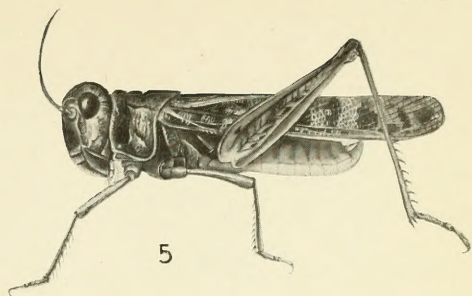
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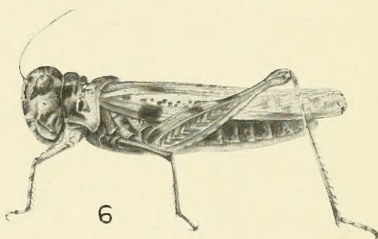
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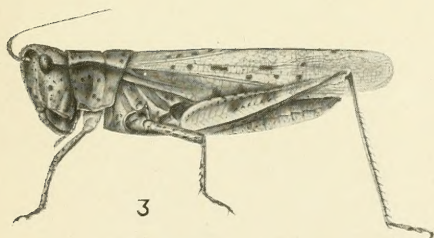
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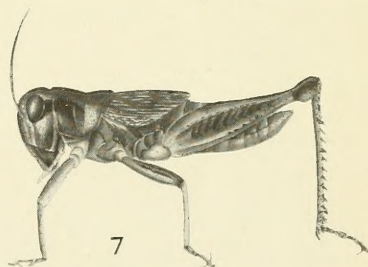
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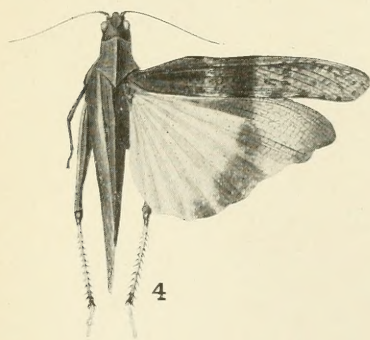
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